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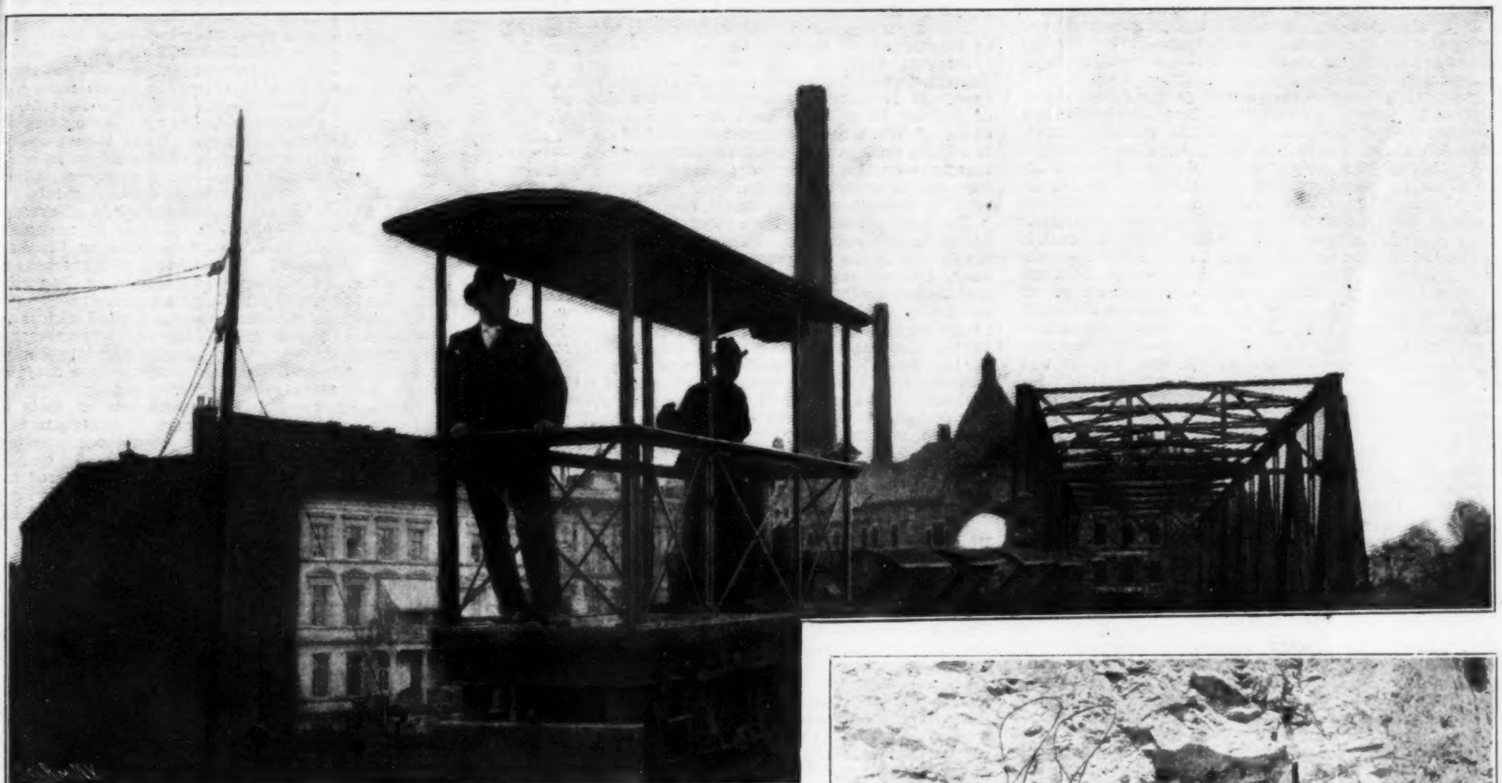
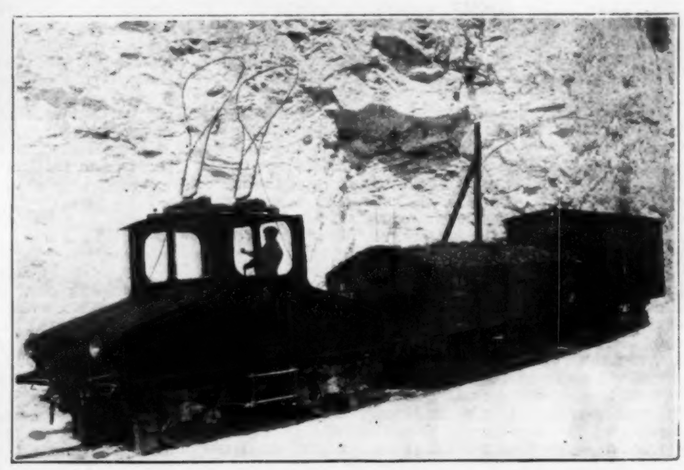
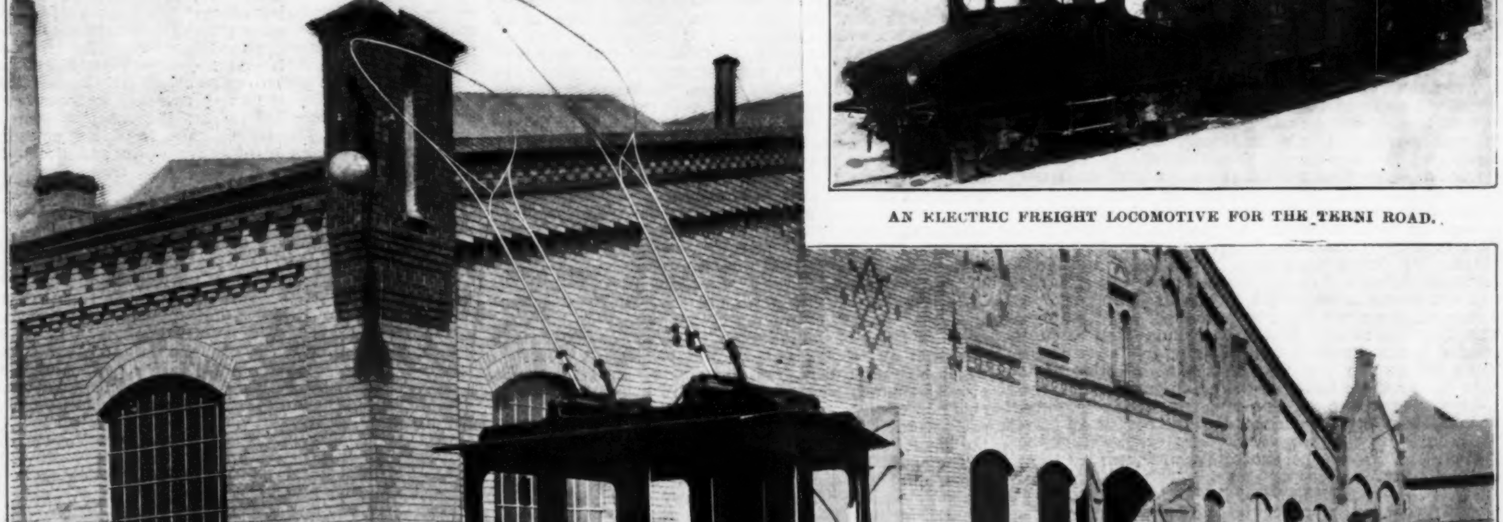


ELECTRIC LOCOMOTIVE FOR SUPPLY TRAIN OF THE BERLIN ELEVATED AND UNDERGROUND RAILROAD.



AN ELECTRIC FREIGHT LOCOMOTIVE FOR THE TERNI ROAD.



ELECTRIC LOCOMOTIVE OF THE GERAER STREET RAILWAY.

ELECTRIC LOCOMOTIVES FOR FREIGHT AND SUPPLY TRAINS.

ELECTRIC FREIGHT LOCOMOTIVES.

ELECTRIC locomotives are particularly well adapted for the hauling of freight. It is inadvisable to provide freight cars with motors; since for freight traffic long trains are necessary, the individual cars of which must often be dropped at some siding.

In Europe, and particularly in Germany, the use of electric locomotives for the hauling of freight has been developed to a greater extent than in this country. Typical electric locomotives of this character are those illustrated and manufactured by Siemens & Halske, of Berlin. On the Berlin electric underground and elevated railway, recently described in the columns of the SCIENTIFIC AMERICAN SUPPLEMENT, special locomotives are used for the purpose of hauling supplies. These locomotives are designed to meet the particular requirements of the road. Ordinarily, the locomotives for the supply trains comprise a substantial rectangular frame resting on the axles, the shocks being taken up by coiled springs. A maximum voltage of about 500 is used. The locomotives are equipped with two motors, for the reason that the adhesion to the rail is greater, and that better efficiency in general is obtained.

The mining locomotives as well as the freight locomotives in general possess the characteristics which have come to distinguish the electric vehicles of Siemens & Halske. Current is taken from the overhead wires through the usual bows, held in contact with the wires by coiled springs. In changing the direction of travel, the bow automatically swings back, and assumes the proper position. The electrical resistances employed consist of sheet-iron panels separated by insulating sheets of asbestos. The resistance panels thus constituted are fireproof. The motors are typical street railway motors. In accordance with street railway practice, they are mounted adjacent to the axle, and embrace the axle at one side of two broad bearings. On the other side they rest in a bearing supported from the lower frame by springs. The axle is driven by an ordinary spur and pinion gearing, inclosed in a dust-proof, protective casing. The casings for the motors are formed by the magnet yokes, which inclose the armature in a water-tight and dust-proof manner. The magnets are of cast steel and are four-poled. The casings are made in two parts, so that one part can be swung aside in order to permit inspection of the interior parts. Automatic switches are distributed throughout the locomotive. Excellent examples of locomotives are to be found on the Gerner street railway and the Terni road of upper Italy.

NEW PROCESS FOR THE PREPARATION OF PHOSPHORUS.

IN principle the process consists in first converting the original materials, which are preferably natural phosphates, into metallic phosphides, such as ferric phosphide, then reducing these metallic phosphides by a reducing agent, such as a sulphide, ferric bisulphide, for example.

Practically the conversion of the natural phosphate into phosphide will be effected by treating in a blast furnace or any other furnace of suitable pressure, a mixture of phosphates and iron ores. Thus, on treating a mixture of 100 parts of phosphates and 100 parts of ores, 66 parts of water, carbonic acid and oxygen are eliminated. These pass to the state of carbon oxide and other volatile matters, and 60 to 61 parts of phosphide nearly pure are drawn off.

If the phosphide is afterward treated by melting it in an appropriate apparatus with ferric bisulphide, for example, in proportions corresponding to the chemical equivalents, the iron will pass to the state of protosulphide. These sulphides, which oxidize in moist air, are thus converted into ferrous sulphates, which constitute quite an important sub-product. The phosphorus is disengaged in the state of vapor, and may be readily collected in a condenser; the residues are liquid and may be collected or evacuated. It is understood that the matter treated (metallic phosphide) not being acid, and on the other hand not being susceptible of giving place to abundant disengagement of gas, proceeding from secondary reactions, it becomes possible to employ crucibles, retorts or other fusing apparatus of large dimensions capable of receiving stronger charges. The apparatus, not being attacked and not accumulating solid residues necessary to be destroyed, can serve for a large number of operations. The heat is readily transmitted, and the reaction effected quite regularly and rapidly, the whole mass being fluid. The result is that the operation lasts only two or three hours at the maximum.

By this process a very pure phosphorus is obtained, and obtained more rapidly and in larger quantities, while utilizing a less costly first material.—From the French (La Revue des Produits Chimiques).—Patent of M. Krauss.

NEW DECIMAL REGISTERING CHRONOGRAPH—DE SARRAUTON'S SYSTEM.

THE problem of the extension of the decimal system to the measures of time and of the circle now occupies the attention of scientific minds in all countries. It will be remembered that the commission on the decimalization of time and of the circle concluded almost unanimously on the following measures:

1. The maintenance of the present division of the day into 24 hours.

2. Decimalization of the interval of the hour into 100 parts, instead of the old 60 minutes, and of each centesimal division of the hour into 100 divisions instead of 60.

3. The day henceforth to be counted continuously from 0 to 24 hours.

Since 1900, L'Annuaire du Bureau des Longitudes has conformed to this last provision.

The plan of the decimal day has been abandoned, the reform being restricted to the decimal hour, as long recommended by M. Henri de Sarrauton, vice-president of the Geological Society of Oran. His propositions have received the support of various scientific bodies, who have not feared that the application would revolutionize or even derange appreciably the habits of the public during the transitory period. The watchmaking industry has commenced the furnishing of the necessary watches for indicating the decimal time, but an instrument remained to be produced, indispensable to navigators, to geographers, to astronomers, to physicists and scientists of every class, who not only must ascertain the time with strict precision, but register readily the duration of successive observations. M. Paul Ditisheim, of La Chaux-du-Fonds, who for a long time has applied himself to various types of decimal horary systems, and was the first in Switzerland to make tropometers,* has produced this new apparatus.

It counts the hours from 0 to 24, but also allows the numbering of them in two periods of twelve hours. It divides the hours into 10,000, and the ten-thousandths into two beats, for which the decimal numbers are furnished; indications more intelligible, more precise, and incomparably more suitable for calculation, than those of the ordinary chronographs, in which the second is divided into five beats, and consequently into eighteen thousand parts.

This reform presents the very great advantage of corresponding to the division of the circle into 240 centesimal degrees; a perfect concordance is established between the measure of the arc and that of the time. It is sufficient to divide by ten any number of degrees, in order to have its expression in unities of time. When there is occasion to ascertain the time, it will be read in hours, minutes, and seconds. If the longitude on the terrestrial globe, or the right ascension on the celestial sphere, is to be ascertained, it is read in degrees, primes, and thirds.

The hands, animated by a continuous movement, indicate in decimal time. The rate of the two chronograph hands is independent of the hands of the hour, minute, and second; the hand beats the decimal half-second; like the second hand, it makes a revolution for each decimal minute. The number of the decimal minutes that have passed is registered by the instantaneous leap of the hand. The reading of the secondary units is facilitated by the rapid movement of the chronograph hand and by the subdivisions of the dial, which are much more spaced than the fifths of the second of the sexagesimal system. A knob governs the functions of the chronograph, which succeed each other in the usual order by three successive pushes: 1. Setting the apparatus going. 2. Stopping. 3. Return to the initial point of the hands, which are ready to register a new observation.

The description shows sufficiently the real service which the new chronograph will render to science. It will facilitate observations and calculations, rendering them much more simple and rapid. The chances of error will be almost null.

M. De Sarrauton presented to the Congress of the French Geographical Societies at Oran in April, 1902, the first chronograph constructed by M. Ditisheim. After the explanations of M. De Sarrauton, the Congress, resuming the opinions they had formed at previous gatherings, unanimously expressed the wish that the government would make suitable arrangements for rendering official the decimalization of the time, and of the corresponding arc of the circle, with as little delay as possible.

Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from the Revue Internationale de l'Horlogerie.

* Decimal chronometers for the measure of longitudes at sea.

SUPERHEATED STEAM.†

By E. H. FOSTER.

WHILE in the march of progress we have been gradually raising our steam pressures, we have kept pace with the corresponding increase of temperature by improvements in construction, until we find that we have already removed the barriers and paved the way for the introduction of superheated steam. Fortunately for us a revival of this practice was inaugurated in other countries some 15 years ago, or long enough to build up a mass of experience which has materially aided us in taking up the work where European engineers, and particularly the Germans, have left off. While it is difficult to form an exact estimate, there have probably been as many as 7,000, and possibly more, superheaters successfully installed by European manufacturers during the past 10 or 15 years, and the fact that the number of installations is rapidly increasing is the best proof that they are on the right track.

Not many years ago the question of how to obtain superheat in our steam might have been difficult to answer. Much of the indifference to superheated steam has been due to the unreliability of the superheater, which has not always been of proper design, but at the present time there is no difficulty in obtaining a suitable and efficient apparatus at a reasonable cost. There are several good makes on the market, each possessing advantages of its own.

The general method of superheating steam is to take the saturated steam from a boiler drum and pass it through coils surrounded by heated gases. The coils may be placed within the boiler setting, so as to intercept the gases from the boiler furnace in their passage through the boiler, or they may be placed in a setting independent of the boiler and supplied with heat by a furnace of their own, or they may be set outside of the boiler and supplied with heat by drawing a portion of the hot gases from the boiler furnace, passing it through the superheater, and returning it to the boiler or economizer. The choice of a system must depend largely upon local conditions, such as space available, the style and size of boiler in use, arrangement of the steam piping, type of engines adopted and their location with reference to the boilers.

The coils are made of seamless drawn steel tubing, or of cast iron of a suitable composition to stand high temperatures, important advantages being claimed for each. Whatever the method of construction adopted, the material used must be of the very best, and the joints and connections made in the most approved manner and with the greatest care. With such precautions as are now considered good practice, the superheater may be depended upon as safely as the boiler, or engine, or any other part of the plant.

† From a paper read before the Engine Builders' Association, New York meeting, December 1, 1902.

ADVANTAGES OF SUPERHEATING.

In considering the advantages and disadvantages of superheating with regard to engine work, let us recognize the four distinct conditions under which steam is used:

Saturated.
Superdried.
Moderately superheated.
Highly superheated.

Saturated steam may be taken as commercially dry steam, or such as is delivered by a good boiler under ordinary conditions.

By superdried steam we mean steam which is not only thoroughly dried in the superheater, but which is raised in temperature 30 or 40 degrees above the saturation point, or just enough to insure its arriving at the engine in a perfectly dry state. To such an arrangement there could possibly be no objection, as the steam is delivered at the engine free from moisture and without the use of a separator or means of trapping out condensation.

By a moderate superheat we mean from 100 to 150 degrees at the boiler, which should give in the neighborhood of 100 degrees at the engine, and be sufficient, with proper protection, to carry the steam nearly, if not quite, through one cylinder without condensation. If the engine is compound, the steam, having lost its superheat at the terminal point of the high pressure cylinder, is resuperheated about 100 degrees in a reheater between the high and low pressure cylinders, and again loses its superheat while expanding into the low pressure cylinder, arriving at the point of exhaust with the temperature of saturation. This arrangement may be considered at the present time as the best which can be proposed. The amount of superheat is so moderate as not to require anything more than good construction for modern high steam pressure.

Highly superheated steam must be treated with more consideration. Engines which will stand a temperature of 500 degrees F. are not necessarily fitted to handle steam at 750 degrees, but these temperatures may be, and have been repeatedly, used successfully.

As shown by many published reports of tests at various points of superheat, an increase in temperature is accompanied by a decrease in steam consumption, hence it is worth while pursuing this line. To employ these high temperatures it is at present considered important to use poppet valves on the high pressure cylinders at least, as it is here that the full effect of the superheat is felt, and this type of valve is easier to lubricate and does not become distorted with heat. We believe, however, that a Corliss valve may be so proportioned as to operate successfully under even these conditions.

THE SCHMIDT SYSTEM.

One of the well-known methods of utilizing high superheat is that known as the Schmidt system. This consists in passing a portion of the highly superheated steam directly from the boiler through the reheating tubes of a receiver, between the high and low pressure cylinders of a compound engine, and then letting this steam mix with that which enters the high pressure cylinder direct from the boiler. The high pressure exhaust is thus superheated on its way to the low pressure cylinder, while the temperature of the steam admitted to the high pressure cylinder is modified by its admixture with steam which has already been through the reheater coils, and incidentally a receiver drain is unnecessary. Automatic regulation of the superheat to a desirable point in each cylinder, under a varying load, is claimed for this system. Ordinarily an increase of load beyond normal, necessitating a late point of cut-off in the high pressure cylinder, will give an excess of superheat in this cylinder, while the reheater will not be sufficiently active to superheat this steam on its way to the second cylinder. With the Schmidt system, however, the effect is reversed by causing a greater amount of steam to pass through the receiver coils, where it gives up its superheat to the low pressure cylinder during periods of heavy draft, and the high pressure cylinder is thus protected from excessive heat. The contrary effect in both instances may be followed through in the case of an engine running under a light load.

MODERATE SUPERHEATING.

In the present state of the art, it would seem that the condition most attractive to American engine builders would be one of moderate superheat. We thus confine ourselves to a conservative policy and avoid the necessity for making any special provision for extremely high temperature. We use lubricants and gaskets and packing which may be obtained in the open market at a reasonable cost, while at the same time we avail ourselves of such positive and direct benefits of superheating as:

Dry steam in the pipes and throughout the engine.
Elimination of separator.
Low steam consumption per unit of work done.
Smaller steam pipes and ports.
Simplified system of steam jackets.
Greater amount of work done per boiler capacity.
Efficiency at light loads.

These are all practical and common sense improvements, and are of such proportion as to fix our attention.

The absence of water with the steam need not be dwelt upon. Every practical man will admit that this is of great value. It is further noticeable that a steam pipe system which will show a leakage at the joints with saturated steam, will become perfectly tight under superheated steam.

The point of maximum economy, while using superheated steam, has by no means been reached. The amount of data available is not in proportion to the extent of the practice. In order to make a comparison between superheated and saturated steam consumption of an engine it is, of course, only fair to place both on a heat unit basis, thus eliminating entirely the question of the cost of the superheat. Assuming a compound engine of about 1,000 horse power and running with 150 pounds initial and 26-inch vacuum, we would consider $12\frac{1}{2}$ pounds of fuel per indicated horse power per hour a very good result. We have well authenticated reports of a similar engine, supplied with steam with a temperature of 720 degrees F. at the boiler, consuming less than 9 pounds of steam per indicated

horse power, or a gain of 39 per cent in economy with an expenditure of but 16 per cent more heat units in the boiler.

The reduction in the size of steam pipes and ports rendered possible by using superheated steam, is due to the diminished density of an equal volume as compared with saturated steam, as well as from the absence of entrained water. The velocity of superheated steam in pipes should be kept up in the neighborhood of 6,000 feet per minute. As a rough approximation, it may be said that superheating will make a difference of 20 per cent in the size of the steam pipe.

The question of steam jackets on a cylinder, which has occupied so much profound attention in recent years, is quickly solved by the aid of superheated steam, and we see at once the benefit of the jacket disappear as a steam economizer. There seems to be no excuse for retaining them on the low pressure cylinder, and indeed we have proved by trial that on this cylinder a steam jacket is positively wasteful. We do not think it is clearly proved, however, that they may not still be useful when applied to the high pressure cylinder, even if only for the sake of warming a large engine up preliminary to starting.

The effect of getting more work out of a certain volume of steam is naturally felt in the handling of the boilers and in a reduction in the number of fires necessary to do a given amount of work.

Unexpected results have been frequently obtained by the addition of a superheater to a boiler, and a higher evaporative efficiency with the superheater in commission has been shown. This is doubtless due to the increase of the heating surface and the lowering of the temperature of the flue gases. In such cases the saving by superheating is felt in the coal pile to the same extent as in the steam consumption.

On the acceptance test of some vertical compound engines of 1,200 and 2,400 horse power on electric light service in Boston, the maintaining of efficiency under light loads was well demonstrated. The feed water per indicated horse power per hour was 12.54, 12.51, and 12.06 pounds at full load, three-quarter load, and one-half load respectively, while the amount of superheat was 80 degrees, 64 degrees, and 48 degrees at the high pressure admission and 60 degrees, 67 degrees and 84 degrees at the low pressure admission. The engine had reheaters and steam jackets on both cylinders, and it is not unlikely that still better results would have been obtained had the low pressure jackets been omitted.

PREPARATIONS FOR THE USE OF SUPERHEATED STEAM.

It must not be considered necessary to make any very extensive preparations for the use of superheated steam. It may almost be said that the requirements are merely in the line of good practice, and, as such, should be inaugurated in any event. It is important to have the joints of the steam pipes firmly made and well bolted; corrugated brass gaskets are usually found very satisfactory with superheated steam. Provision must, of course, be made for the expansion and contraction of the steam lines to a somewhat greater extent than ordinarily, and the steam pipes, as well as the flanged unions, should be covered with a good non-conducting material in a thick layer. It is important to have the flanged unions covered as well as the pipe.

With proper precautions of this sort, and with a velocity of steam in the pipes of from 4,000 to 6,000 feet per minute, the drop in temperature per foot of run may easily be kept down to 1 degree in 6 or 7 feet of length.

Metal of low melting point must, of course, be avoided in the construction of the engine, especially about the valves and piston rods. The stuffing box bushings must be made of metal which will not run under the temperatures likely to be encountered. The metal should be uniformly distributed, in designing the valves and cylinders, to get the best results with superheated steam, as in this way a uniform expansion by heat is provided for. The barrels of the cylinders are preferably made without projections or ribs. The poppet valve has the advantage in form, but the Corliss valve is also made in such a manner as to expand and contract without warping, and the large number of Corliss engines using superheated steam is a strong evidence of their adaptability.

The lubrication of the cylinders is apt to cause one who has not had experience with superheated steam a great deal of unnecessary anxiety, but really this problem is very simple. It must be borne in mind that the temperature inside of the cylinder is never very high, even when the superheat at the entrance is very considerable, and if the cylinder is lubricated directly without mixing the oil with the steam at the entrance point, there can possibly be no difficulty. With any reasonably good grade mineral oil, however, it cannot be claimed that any difficulty has been experienced with the lubrication of the parts, even when applied in the ordinary way.

The effect of superheated steam in the indicator diagrams is worthy of notice. Steam being used as a perfect gas, the diagram approaches more nearly the theoretical, and, as there can be no re-evaporation in the cylinder, the tendency of the pressure to rise during the stroke is absent, and the amount of work done in the low pressure cylinder is brought down to the proper point. In designing an engine to be run with superheated steam, it is well to bear this point in mind, as there is danger of applying the usual constants in the selection of the size of the cylinder, for the reason that the horse power of the steam end used with superheated steam will be nearer the theoretical.

Although there has been less experience in using superheated steam on locomotives, it cannot be said that this field is of minor importance. Trials have been made on the Canadian Pacific Railway, and are now being conducted on the Pennsylvania Railroad, which will doubtless contribute much to the knowledge of this subject. In the former instance it was found that by the addition of a superheater a simple engine weighing 204,000 pounds was enabled to do 60 per cent better in equivalent ton miles hauled per ton of coal than a similar engine without superheated steam, and 30 per cent better than a compound engine without superheated steam. We should expect better results from a compound engine with superheated steam, and doubtless later experiments will bring out this feature. It is of inestimable importance to railroads if, as is apparently true, with the same boiler power, they are able to use larger cylinders and haul more cars.

Superheated steam is destined to play an important part in the adoption of the steam turbine. Already a number of tests have been published which show a considerable decrease in the steam consumption with the amount of superheating, and it is not difficult to understand that a machine of this type would be greatly benefited, even by the elimination of moisture and dense vapor from the propelling medium.

Other uses for superheated steam, such as for driers, chemical processes, and boiling or distilling apparatus, will not be touched upon in this paper, and it may be said in conclusion that the author believes that the time has arrived when steam will not be used to any great extent in any branch of industry without being superheated.

THE ORIGIN AND CONSTRUCTION OF THE IONIC VOLUTE.

At a meeting of the English Institute of Architects, Mr. F. C. Penrose discussed the origin of the Ionic volute.

He stated that several methods, none of them very successful, had been proposed for the construction of the Ionic volute by means of finding centers for quadrants of circles, which may give some approximation to the appearance of the true figure of the Greek originals. That of Goldman seemed to be the best, but it failed altogether to give the proper proportional expansion of the spaces between the lines, nor did the four jumps in each convolution at all represent the beauty of the continuous gradation of Greek originals. The origin of the volute, sought for in Assyria, Egypt and elsewhere, the author derived from Greece itself, as the scheme he was about to explain enabled the exact figure of any true Greek example to be reproduced. In archaic Greek work, and particularly in the decorations of the Mycenean period, one constantly found the form of scroll in which every convolution of the spiral followed the first at equal intervals. This decorative scroll had no doubt been formed mechanically, as could easily be done by unwinding a string from a cylinder, forming a figure known as the involute of the circle. The question presented itself, how could a spiral having the character of the ammonite be produced? If the operator drew upon wood—or some other suitable material—the involute scroll, such as he had been accustomed to, and by shallow carving or otherwise, raised the edges a little so as to form a helix, and allow a string to be wound round those edges, and then unwound over a flat surface having a marker at the extremity of the string, he would produce the expanding spiral he was in search of. It did not give correctly the figure of the ammonite, but it had all the requisites of proportional expansion and perfect variation of curvature at every point, and coincided perfectly with Greek volutes.

The author gave two examples from Ephesus—the first from the archaic Temple of Diana. In all later examples known to the author, the two central convolutions of the spiral, or nearly so, were interrupted and concealed by the circle which formed the eye of the volute. In this case, however, the curve which would be evolved from the helix was allowed to extend from the central origin of the volute up to its junction with the abacus. By drawing a straight line through the central origin to the circumference, on both sides a calculation could be made to find a helix on the involute principle, and this, when worked out, would be found to agree not only with given points on the circumference, but to correspond with the inner convolutions also, and could therefore be extended to the whole of the volute. This correspondence clearly showed that the method of the involute spiral was that which was used by the architect employed by Crœsus.

The volute of the later temple at Ephesus, the second example, had almost the same curvature, the only difference being in the surface molding and the circular eye which occupied its center. In the majority of the examples known, the eye of the volute was a separate piece from the main mass of the capital, and was formed by some kind of boss of marble or metal inserted into a circular hole prepared for it, centered very nearly on the place of the pivot of the helix, and always of sufficient diameter to receive it. Such an arrangement would have had obvious convenience for fixing the helix.

The volutes in all the examples in Asia Minor were probably described by means of helices similar to that mentioned above. But the Athenians demanded greater variety than that spiral so used could supply, and gave to their volutes additional expansion in the exterior convolution; still, however, working so by means of the involute form, but differently treated. This applies to the Propylæa, to the three orders of different size in the Erechtheum, and to the Temple of Nikè. It was also used in the temple on the Ilyssus, recorded by Stuart, and in the provincial temple at Bassæ. With the exception of this variation in the exterior convolution in Athenian structures, the same general scheme seems to have been employed in all true Greek examples, and the only liberty of choice given to the designers lay in the proportioning of the width of the volute to the upper diameter of the column, and in that of the interval between the convolutions of the generating helix, in the size of the eye compared with that of the volute. This would have some effect upon the number of convolutions to be used, which vary in the cases the author had examined from four (that is, measured from the origin) at Priene, to two and a quarter in the case of the Erechtheum. The intervals of the helix would determine all other variations. The variations in the above-mentioned elements, as found in certain examples, were shown in a table of calculations. The two different descriptions of volute he termed the Asiatic and the Attic.

The author next gave a description of the helix for describing the Greek volute, and detailed the method of its employment both in the Asiatic form and the Attic variation, illustrating by various diagrams and giving a table of calculated measurements. Mr. Penrose proved the accuracy of his method by showing that examples of volutes on the east portico of the Erechtheum and at the Propylæa, worked out in the way he had described and from data given by the table, were found to be exact in agreement with the records made by Stuart of the Erechtheum and by Mr. T. J. Wilson of the Propylæa.

Before concluding, the author gave an interesting description, illustrated by diagrams, of the helix (one from which a string may be unwound so as to produce the volute) employed by him in drawing the models exhibited, and suggested the adoption of a similar contrivance where a Greek volute had to be carved.

SPECTACLE REPAIRING.

A USEFUL article on spectacle repairing appears in the New York Optical Journal. The instructions are practical and will be of use to opticians in repairing of odd jobs. For a broken nose-piece the author says: "Presuming the optician to be in possession of files, saw frame, etc., but few appliances are necessary. An alcohol lamp, blow-pipe, borax, slate, and asbestos pad will enable him to perform any job presented for repairs. We will now take for instance a spectacle frame broken near the bend in the nose-piece. First file off the broken surface to a perfect union. Take plenty of pains in filing up the point to as perfect a fit as possible, as the life of the job depends to a great extent on the perfection of the joint. Lay the pieces into position on the asbestos pad and secure them by means of L-shaped pins thrust down into the pad. Now take a small piece of borax, lay it on the piece of slate, add a few drops of water, and with a rotary motion grind enough borax into the water to form a thin paste. Apply this borax to the point, flowing it well in between the surface, and lay the small piece of solder over the break, flash the flame over the frame to expel the water from the borax and to cause the solder to adhere to the frame. Now paint over the surfaces with anti-oxidizer, being careful not to put too heavy a coat over the joint. Too heavy a coating will prevent the solder from flowing. In soldering, heat the parts on either side of the break to red heat, then bring flame to a focus on the solder. Many beginners in hard soldering imagine that all that is necessary in soldering is to heat the solder without regard to the surface on which the solder is to flow; as a result the solder "balls up," and no amount of blowing directly on the solder will cause it to flow. It may be well to remember that in order to do good hard soldering the surface must be as hot as the solder. After soldering, frame should be boiled out in sulphuric acid, one part to fourteen parts of water, then filed up smooth, emeried, and polished in the usual manner.

"A good anti-oxidizer for covering spectacles and all articles of jewelry to prevent fire coat is prepared as follows: Take one part of boracic acid and four parts of yellow ocher, and add enough water to form a thin paste. Boil over a slow fire for one half an hour, and when cool, the mixture is ready for use. An anti-oxidizer is essential if one would do good work. Without it the frames, when finished, present a greenish appearance, which is hard to remove. This fire coat is caused by the action of the air on the metal contained within the gold as an alloy to reduce it down to the proper carat, and is of different colors, according to the quantity and quality of the alloy. It is really an oxide of the metal. Thus, if silver is used as an alloy, the fire coat will consist of a layer of silver oxide. The anti-oxidizer covers the surface and prevents the air from uniting with the metal to form an oxide. If not used, it requires more polishing to make the finished job presentable, and as a result the frame is correspondingly weakened at the point soldered.

"In soldering a broken end-piece, we have a frame in which the eye-wire is broken up close to the end-piece. The method of heating and soldering is, of course, the same, no matter where the break may be located. All that is now necessary in explaining the various repairs is to point out the manner of holding the frame during the process of heating. In the above frame we remove the screw and rivet, file up the broken surfaces (but little; if too much, the lens will not fit the eye-wire), and place them in position on the asbestos pad. A piece of thin sheet asbestos is placed between the two sides of the end-piece (were it not for this we would occasionally find the two sides soldered together), and a piece of V-shaped wire sharpened at the points is thrust down into the asbestos over the end-piece to hold the two sides together. Then solder as before described. Use but a small amount of solder on this, as well as on all other repairs. You will be surprised, upon trying, to find how little is necessary. If just the proper amount is used, it will just fill in the space between the surfaces nicely. After the frame is boiled out, all that is necessary is to smooth it down with a fine emery stick, when it is ready for the polishing lathe. On the other hand, the excess has to be filed off, and before we know it, we have filed down into the frame, weakened it, and in a month we have the same frame, broken at the same place, back for repairs.

"With the light gold frames that are turned out by the factories to-day, the repairer finds breakages of the eye-wire a frequent occurrence. If he wishes to do satisfactory work he will not merely solder the eye-wire, he will put a reinforcement on it. The eye-wires of to-day are so thin that there is no surface for the solder to adhere to. Often after we get the frame all soldered and emeried it will snap apart while polishing. To reinforce a frame, we will first get out a piece of gold of the same width as the eye-wire, of the same quality, and about ¼ inch long. With a pair of pliers we get this piece the same shape as the eye-wire, and with a rat-tail file fit it to the eye-wire as closely as possible. Now we will get out a piece of sheet asbestos about 1-32 thick, shaped like one-half of a split bifocal lens, and round the edges so that it will fit into the groove of the eye-wire. We will now press the break up together, fit it in the asbestos piece, lay on the piece of reinforcement, adjust the whole to position, and bind securely with iron binding wire. Now flow borax paste well in between reinforcement and eye-wire, and in this instance we will use two bits of solder, one on either side of the reinforcement, to insure solder flowing well in between the two. Solder in the usual manner. After the optician has repaired a few frames in this manner he will admit that it is as easily and nearly as quickly accomplished as the old method, and he may rest assured that if the job is properly done, he need

have no fears in guaranteeing it to last as long as the frame. Should the temple be broken up near the bend which fits over the ear, the best course is to repair it with a temple ferrule, which can be obtained from any material dealer, and the writer would advocate the use of soft solder to fasten the ferrule to the temple. If hard solder is used, the metal is annealed. It is unnecessary to use a ferrule where the break is near the joint or even when it is up toward the middle of the temple; such breaks should be hard soldered. But when in the bend, the ferrule should be used, as otherwise the temple would always be out of shape from putting frame in and taking it out of its case. For a hard-solder job, we should first file up the broken parts to form a long lap joint. This is to give additional strength by means of allowing a larger surface for the solder to flow on. Pieces should be held in position on the pad by means of the L-shaped pins while being soldered. Use but a small piece of solder, as you will find from experience that it is not an easy task to remove excess of solder from a spectacle temple without filing into the temple."

ELECTRIC ELEVATORS.

ELECTRIC elevators have, during the last few years, come into very general use, and their simple arrangements have caused their adoption in the majority of the new structures of Paris. The electric energy for operating them is readily obtained from the city electric light mains, and the manufacturers, by introducing various contrivances, have succeeded in simplifying their management and in making their operation entirely satisfactory. The cheapness with which they can be run is likewise a reason that has caused them to be preferred to hydraulic, compressed air, and aero-hydraulic elevators.

In the following article, we shall pass in review the principal types of electric elevators that are now used in Paris. We shall examine in succession:

1. Elevators without shaft, but with counterpoise and electric windlass.

2. Elevators with shaft, and with compensators actuated electrically.

3. Hydro-electric elevators.

1. Elevators Without Shaft, but With Counterpoise and Electric Windlass.—The general arrangement of the operating machinery, in elevators of this class, consists of an electric windlass around the drum of which wind cables that pass over wheels at the top of the shaft and support the elevator car. A counterpoise, the cables of which wind around the same drum in the opposite direction, balances the weight of the empty car plus a half-load. The motor, therefore, has to furnish only the power necessary for lifting half of the load. The work is the same for raising the car with a full load as for causing it to descend empty. The motor consequently works in most cases at a power bordering on that for which it is calculated—a condition necessary for obtaining proper efficiency. In some installations, the greatest part of the weight of the car is simply balanced by a counterpoise placed upon the lifting part of the cable, and often, even, when the arrangement of the building does not make it easily applicable, the counterpoise is done away with altogether.

Fig. 1 represents an elevator of the kind constructed by the Abel Pifre establishment, which builds elevators of all sizes.

The windlass consists of a grooved drum upon the shaft of which is keyed a bronze worm-wheel that is in mesh with an endless steel screw connected with the electric motor. The screw and wheel revolve in a tight case filled with oil. The drum is driven by the worm-wheel through an elastic connection that prevents the transmission of the vibrations emanating from the motor and screw, to the suspension cables. The electric motors used are either continuous current motors (wound for 110, 220, or 440 volts) or simple and polyphase alternating current ones. Upon the coupling of the continuous current motor and the endless screw is placed an electro-magnetic brake, the coil of which is connected in parallel at the field terminals of the motor, which is a compound wound machine. When the currents employed are simple alternating ones, the machines made use of are synchronous motors with closed armature, the motor couple of which is sufficient for the starting. Such a result is obtained by means of an auxiliary field winding and a rheostat placed in the circuit of the movable part. At the moment of starting, the resistances are gradually eliminated by the motor in operation, and the auxiliary field winding is cut out.

FIG. 1.—PIFRE ELECTRIC ELEVATOR OPERATED BY A WINDLASS. FIG. 2.—OTIS ELECTRIC ELEVATOR. FIG. 3.—EDOUX ELECTRIC ELEVATOR, WITH BALL SAFETY DEVICE.

The operations necessary for starting the elevator are performed in the car either by means of an endless rope or of electric push buttons. The former, which is attached to the controlling pulley of the apparatus, carries olive-shaped buttons of increasing sizes, and passes through a box operatively connected with the car. This box carries along the rope and brings the apparatus to a stop when it meets with the button corresponding to the story indicated. Each floor door is provided with a device that renders the manipulating rope immovable and prevents the apparatus from being set in operation when any one of the doors is open. Automatic catches, controlled by the car, prevent the opening of the doors until the car comes opposite them. The controlling pulley of the apparatus actuates a commutator switch, which closes the circuit of the motor and sends a current through it in the desired direction, as well as through the coil of the brake. At the moment of starting, resistances are interposed in the circuit of the armature, and these are automatically cut out by electro-magnets as the speed increases. A safety apparatus placed upon the drum of the windlass carries along the manipulating pulley to the end of its travel, and stops the elevator if, through accident, the manipulating rope happens to break.

At present, push-buttons are most generally employed. The circuit of these passes through interrupters actuated by the floor doors, through interrupters controlled by the car for the automatic stoppage at the different stories, and through the coils of an electro-magnetic commutator switch subserving the same purpose as the commutator switch of the manipulating rope. When the buttons are pushed, various electric relays are actuated that operate the switch controlling the motor, remove the starting resistances, and control the coil of the brake for stopping the car.

By a special arrangement, it suffices to press a single button in order to set the car in motion upward or downward, and cause it to stop automatically at the story corresponding to the button pushed.

Finally, arrangements have been adopted such that, when the car has just stopped at a story, it is impossible to set the motor in operation by the external buttons till after the passengers have left the car and the door has been closed.

The worst fault that can be found with the electric elevator is that of being suspended. A cable may break accidentally, and so the car should be provided with an efficient safety apparatus whose operation offers every guarantee of efficiency. It is safe to say that no mechanical device of this kind will ever present the security of a hydraulic piston the descending velocity of which is regulated by that of a volume of water flowing into a pipe of a determinate section. MM. Edoux & Co. employ a ball safety apparatus, the operation of which permits of no chance of accident. This apparatus (Fig. 3) consists of a guiding arrangement in the form of a rack. The car carries a piece of channeled iron firmly secured to its side and provided with a certain number of cavities in which steel balls are housed. The diameter of these balls is slightly less than the depth of the cavities. This piece is therefore capable of moving along the rack without producing any binding so long as the velocity allows the balls to move in the sinuous raceway formed by the safety apparatus. But as soon as the velocity of the car exceeds that which the balls can attain, binding occurs and the car remains stalled by one of the balls. To every critical velocity there corresponds a certain profile of rack having teeth more elongate in proportion as the velocity is greater.

The Otis Elevator Company likewise installs direct electric elevators to be operated with continuous, alternating, or polyphase currents, and which are started and stopped by a button. The electric motor (Fig. 2), which is not very bulky, is placed alongside of the elevator shaft either in the cellar or above the ceiling of the windlass. The difficulty with high speed elevators lies in the necessity of making regular stops without shock, at the different floors, whether the car is loaded or empty. Very good results are obtained by slacking the speed before reaching the landing. This is accomplished in the Otis elevators by reducing the speed of the motor and by arresting the car at the landing by means of a leather band brake. In America, there are what are called "express" elevators, which have an electric windlass, and which attain a speed of 11.5 feet a second.

The new system of button control introduced by the Otis Company, does away with the automatic stoppage-box of the present systems, as well as with the other buttons placed in the car, there being substituted for them simple electric buttons fixed vertically one above another, and of a number equal to that of the different floors. Upon pushing one of these buttons, the car is immediately set in motion and stops of itself at the proper floor. For external control, each floor door is provided with an electric button analogous to that of the car, and producing the same effect. These external and internal buttons have no action so long as the car is not at rest and all the doors are not closed. Moreover, the external buttons are neutralized as soon as any one of the buttons of the car is actuated. It follows that it is impossible, upon the stoppage of the car at a landing, to reverse its motion by pushing a descending button. In order to make it possible to cause the descent of the car from the exterior, it is necessary that the person who runs it shall have opened and closed the floor door.

MM. Samain & Co. also are constructing various types of direct electric elevators actuated by continuous and alternating currents. They employ special safety brakes, and the manipulations are effected by means of electric buttons or of ropes, but through the intervention of auxiliary hydraulic motors instead of electric ones.

In 1898, MM. Guyenet and De Mocomble were led to study the direct application of an electric windlass with spur gearing to an elevator with hydraulic piston.

The Pifre establishment is constructing passenger and freight elevators with electric windlasses of all powers, from the lift actuated by a ½ horse power motor to elevators in service in the large Parisian stores. In "La Samaritaine" stores, it has installed an elevator with electric windlass that raises a load of 2,200 pounds (say 15 persons) with a velocity of 4.1 feet per second. A 30 horse power motor is used.

MM. Edoux & Co. have installed 15 elevators in the Orsay Station at Paris. These elevators are calculated for a load of 1,100 pounds at a velocity of 3.28 feet per second, or a load of 2,200 pounds at a velocity of 1.64 feet per second. The current consumption is 12 amperes at 500 volts, which corresponds to an output of 0.2 of a hectowatt hour for the raising of a load of 2,200 pounds to a height of 16.5 feet.

The Otis Company is constructing low or high speed elevators (from 1 foot to 11.5 feet per second) for weights of from 440 pounds to 8 tons, requiring electric motors of from 2 to 100 horse power. Through the pressure of a numbered button by the man in charge, the elevator starts, accelerates its speed at first, slows down before stopping, and, without shock, stops at the floor desired, either when empty or loaded.

2. Elevators with Shaft, and with Compensators Actuated by Electricity.—Elevators with electric compensators have the advantage of permitting of limiting the descending velocity by regulating the flow of water through a pipe of a determinate section. Fig. 4, No. 1, shows the arrangements adopted by the Pifre establishment. The car is carried by a steel piston, *A*, that plunges into a cast iron cylinder, *B*, which has a length equal to that of the travel of the car, and which is connected through a pipe, *T*, with the compensator cyl-

inder, *C*, having the same capacity, but of reduced length. The two cylinders are filled with water, thus forming an hydrostatic balance. A piston, *D*, loaded with counterpoises, works in the cylinder of the compensator, and carries at its upper part a nut mounted upon a screw of proper pitch. This screw turns in a stationary collar. An electric motor, *M*, through a belt and bevel-gear, causes the screw to revolve in one direction or the other. The rotary motion of the screw causes the ascent or descent of the nut and, consequently, of the piston of the compensator, and hence of the car. MM. Samain & Co. likewise employ a hydro-electric compensator. The car is actuated by a plunger, *A*, which works in a hydraulic cylinder, *B*, installed in a well (Fig. 4, No. 3). The compensator consists, in principle, of a plunger, *D*, which is capable of rising or descending in a stationary cylinder, *C*. This plunger is actuated by a continuous current electric motor, *M*, which transmits motion to it through the intermedium of a screw, *E* (the bearing point of which is a beam above), that acts upon the piston by means of a nut threaded upon it and secured to the upper extremity of the latter. The cylinders *C* and *B* are connected through a pipe, and are filled with water. The counterpoises, *P* and *P'*, move with the piston upon external guides mathematically constructed. Other arrangements have been made for alternating current motors (Fig. 4, No. 4). The compensator supplies the elevator with the necessary ascensional power. The cylinder, *C*, of the compensator and the cylinder, *B*, of the elevator are connected by a pipe passing through the distributer, *E*, which assures the ascensional motion and the stops. The alternating current electric motor, *M*, which operates only during a descent, is connected with the bottom of the car by a steel cable that winds around a windlass of special form.

3. Hydro-electric Elevators.—This system is employed by preference when it is a question of transforming an existing hydraulic elevator with a minimum of expense. It is employed also when the installation includes several electric passenger or freight elevators.

When the building has a sufficient height, reservoirs connected by a conduit with the distributers of the hydraulic elevators are often placed in the timberwork of the roof. The water employed for the ascent is, during the descent, collected in a tank placed in the cellar. A pump, actuated by an electric motor, sucks the water from this tank and forces it into the reservoirs above. Centrifugal pumps, coupled directly with the motor, are the types generally used. In other installations, in order to obtain a strong pressure, recourse is had to the use of an hydraulic accumulator, which replaces the upper reservoir. Fig. 5 shows the arrangements employed by the Pifre establishment. When the car is started upward, the accumulator descends and forces water into the cylinder of the elevator. In its descending motion, the accumulator closes a switch, which sends the electric current to the motor through an automatic rheostat. After the stoppage of the car, the water under pressure furnished by the pump causes the ascent of the accumulator, which, when it reaches the end of its travel, opens the switch. The motor, as well as the pump, is thus arrested. In the case of an upper reservoir, the switch is controlled by a float which acts as soon as the level has lowered to a sufficient degree.

In large installations that necessitate a powerful motor, the actuating of the starting rheostat is effected by an auxiliary hydraulic motor fed by water under pressure obtained from the force-pipe of the accumulator. It was upon this same principle that MM. Edoux & Co. constructed the four large, 2,200 pound, 3.28 feet per second elevators in the terminal station of the Quai d'Orsay. A group of three electric pumps supplies two coupled hydraulic accumulators controlled automatically. The elevators of the "Hotel Moderne," also installed by MM. Edoux & Co., are likewise actuated by electric pumps and hydraulic accumulators.

Let us mention, in addition, several other important and interesting installations: At the Say sugar refinery there are three hydraulic accumulators of 120 tons each and of a pressure of 715 pounds to the square inch. These are supplied by a battery of four electric pumps, and they actuate 18 freight elevators that raise loads of 6,600 pounds at a velocity of 1.64 feet per second. At the Bank of France there are 45 safe elevators and five freight elevators which are operated by two hydraulic accumulators of 150 tons each, employing a pressure of 500 pounds to the square inch. The accumulators are supplied by two electric pumps. The installation includes an auxiliary gas pump as well as a compressed air one. Finally, we may mention the Edoux installation at the "Hotel Continental," comprising (1) two 80-ton hydraulic accumulators, employing a pressure of 285 pounds to the square inch, that actuate four elevators which raise 1,400 pounds at a velocity of 2 feet per second, and (2) two electric pumps that supply the accumulators.

The installation of hydraulic elevators supplied by pumps and accumulators of water under pressure sometimes includes two distinct pumps, one of which is actuated by steam or compressed air, and the other by an electric motor. It is then possible, without interfering with the operation of the installation, to repair one of the pumps whenever it becomes necessary. It was thus that the Pifre establishment installed the elevators at the "Grand Hotel" of Paris, where it is necessary to have a permanent day and night service. This installation, for the supply of four 1,320-pound elevators having a velocity of 5 feet per second, includes a piston pump actuated by a 35 horse power electric motor, and a 35 horse power Worthington steam pump. The starting of these pumps is done automatically by the accumulator. The pressure of the water is 285 pounds to the square inch. Such are, at present, the principal applications, in Paris, of electric energy to the operating of elevators.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

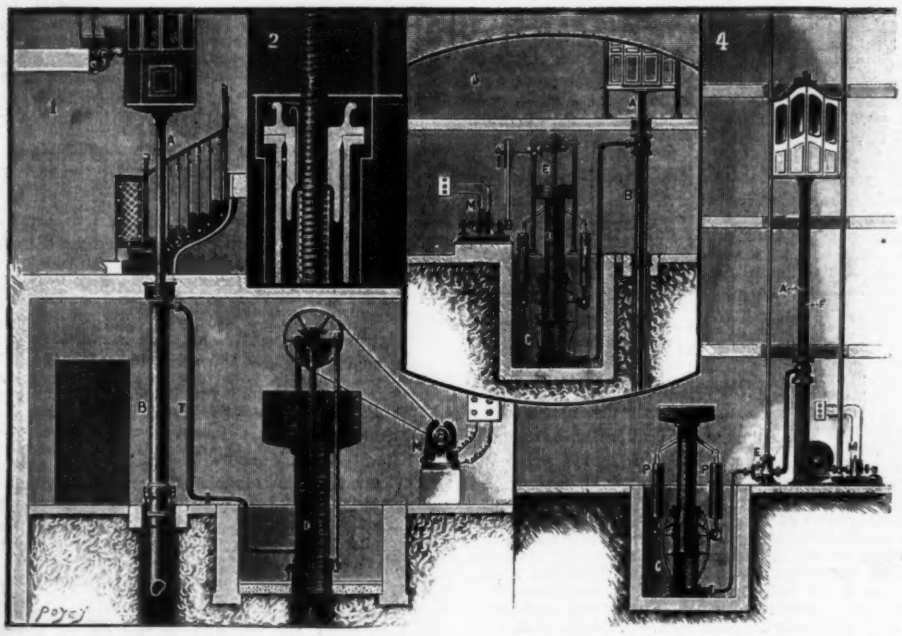


FIG. 4.—1. PIFRE ELECTRIC ELEVATOR WITH COMPENSATOR. 2. DETAILS OF THE COMPENSATOR. 3. SAMAIN ELEVATOR WITH ELECTRIC COMPENSATOR RUN BY DIRECT CURRENT MOTOR. 4. COMPENSATOR WITH ALTERNATING CURRENT MOTOR.

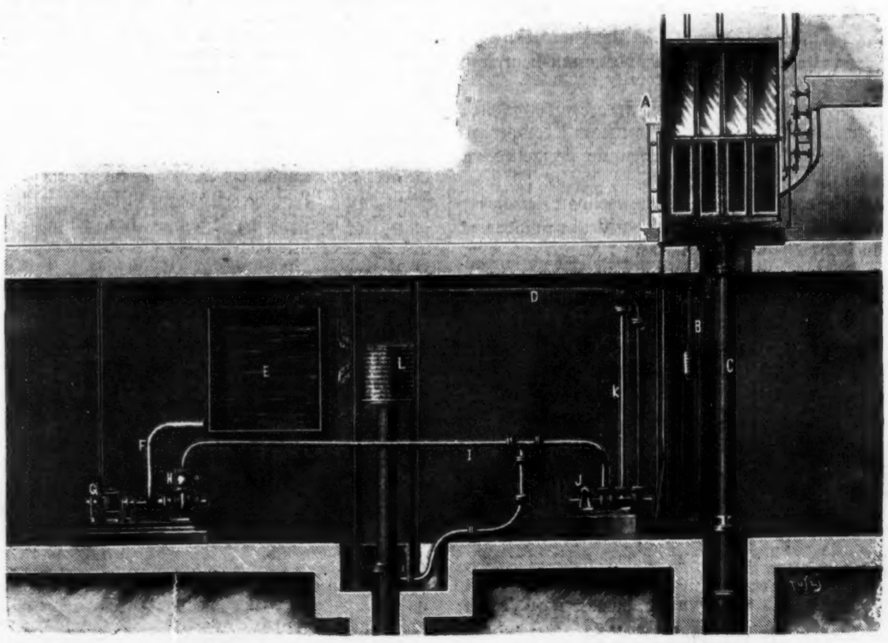


FIG. 5.—PIFRE HYDRO-ELECTRIC ELEVATOR WITH ACCUMULATOR.

A. Manipulating rod; B, rope; C, cylinder; D, pipe; E, reservoir; F, suction pipe; G, electric motor; H, pump; I, force pipe; J, distributer; K, connection pipe; L, hydraulic accumulator.

SURFACE-CONTACT SYSTEMS.

IN London Engineering appears a translation of an abstract from a paper by Mr. G. Paul, of Nuremberg, which may not be without interest. Such a large number of contact systems have recently been recommended for adoption, says Mr. Paul, and their qualities extolled by comparison with other systems of distribution and by taking into account the conditions of traffic in different towns, that it behooves one to ascertain whether, both from electro-technical and practical points of view, they are all suitable for electric traction.

Every one of the systems has been recommended by its advisers as absolutely safe and reliable; practice, however, has often proved the contrary. Several of the systems have also been satisfactory in some towns and not in others. Take the Diatto system, for instance; this has given good results in Lyons and Tours, but in Paris, where the condition of the streets is substantially less favorable, it has been the cause of numerous accidents, all of which can be traced to the fact that the studs remain alive for a time after the cars have passed over them. It is generally admitted that in order to "kill" the stud and do away with all leakages and with all risks of accidents, the apparatus should remain clean, as otherwise an arc is easily produced in the stud-box, this becoming a source of danger when safety devices are not provided, or fail to meet the case. As a means of safety with the Dolter system of surface contact, both ends of the car are fitted with an earthed skate, which strikes on each stud, short-circuiting it, should it have remained alive, the short circuit causing the fuse in the surface contact to melt. One would assume that by this means the safe working of the system would be insured; on further consideration, however, it is easy to see that such a contrivance interferes with the proper working of the system, and tends to reduce rather than to increase its safety as far as road traffic is concerned. Thus, supposing that a stud has remained alive from one cause or another, and that the earthed skate strikes it, producing a short circuit, it is not proved that the fuse would melt; the time during which the earthed skate is over the stud is so very small that the fuse may fail to go, unless it be designed to "blow" with a very small current excess. In this case, however, it will be liable to go when the current intensity is a high one, in starting the cars, for instance, or over heavy gradients. The proportioning of the fuses to meet all the conditions of working is a very difficult matter. Repeated trials have proved that fuses 10 by 1 millimeters (.39 inch by .039 inch) in section, sized for a fusing current of 60 amperes and a load current of 30 amperes, have not been blown when the short-circuiting skate has struck a stud that had remained alive.

Moreover, supposing that the fuse in one of the contact boxes has melted, many days may often elapse before attention is called to the dead stud; the traffic may not suffer any interruption, as by reason of the impetus it has acquired, the car can easily proceed over the next stud, from which current can be taken up. As soon as the car passes over the stud in which the fuse has been blown, a break in the current always occurs at the neighboring stud, and this at the full-current intensity which the car requires corresponding with its load; it means a cutting out of 30 to 40 amperes at 500 volts in the very small space which separates two contacts. The arc thus produced, it is needless to add, would have disastrous effects, and the contact apparatus would very soon get damaged by its being repeated probably every two minutes—every time a car ran over the spot. There is also the danger that the earthed skate may not perform its function, the stud keeping alive notwithstanding, while the arc between both carbon contacts remains in spite of the magnetic blow-out fitted to the movable lever of the contact apparatus. In the descriptions I have seen of the Dolter system nothing is stated as to the manner in which the formation of arcs is to be prevented. It is generally assumed that the surface contact appa-

ratus works sparklessly, as one of them is already under current before the other is cut out. In practice, however, this has been shown to be no more than a supposition, for notwithstanding the most careful insulation of the street contacts, there are small amounts of current flowing to earth; there are also, at times, current losses by leakage, this being especially the case in winter, when salt is resorted to in order to clear the track from snow. It is always asserted, with reference to the Dolter system and all other similar systems, that the stud is always cut out immediately the collecting skate on the car has left it. Experience, however, has shown that when a leakage occurs from the studs to the rails the contacts in the apparatus open out but slowly, and sparking occurs, owing to the residual magnetic flux.

With low current losses, and these should always be reckoned with, the magnetic blow-out will extinguish the arc; but the evil is not prevented from originating. When cutting out suddenly with the full car current intensity the blow-out is not sufficient, and the arc will remain for some time if leakages exist on the street level. The arc will even be greatly increased when the earthed skate on the car strikes the stud, and this skate, placed as a means of safety, may become a source of danger. It has been reported that with the Diatto system in Tours and in Paris the safety device placed on the car was later on dispensed with. It is not easy to understand why a safety device should be considered superfluous, as the numerous accidents which occurred until very lately in Paris with the said system should have afforded a proof that efficient safety appliances cannot be dispensed with in such a surface contact system. In some descriptions of the Dolter system it is said to be an advantage to use double-truck cars, so that all contact studs can be put in the center of the track, instead of a certain number being in dangerous proximity to the rails; this shows plainly that current leakages from the studs to the rails are feared. The use of double-truck cars would, moreover, be a necessary condition with the Dolter system, the fitting of the collecting skates underneath the car not being possible for cars with two rigid axles and two motors, and in which the wheel base is only 5 feet 9 inches. At all events, the Dolter system makes it necessary to use a special type of car, consequently the two-axle street cars that would otherwise be available, could not be used without important alterations. Or supposing that the studs be 9 feet 10 inches apart, the collecting skate must naturally be somewhat longer, or about 11 feet 5¾ inches, so that the front stud may be switched in before the rear one is left. Should the car run at a speed of 10 miles, the speed per second is 14 feet 5 3-16 inches; it is, therefore, absolutely necessary that the safety skate on the car be at least 14 feet 5 3-16 inches distant from the collecting skate, in order that it should not touch a stud which is still active, and cause a short-circuit. But the fact has long since been proved that the cutting-out of a live stud does not proceed in so very rapid and precise a manner, since, owing to the residual magnetic flux (and this is an inherent feature of the Dolter system, the studs being of cast-iron), the contacts do not open instantly. Trials with other similar systems do not allow of any doubt as to this point.

Owing to the important interests now concerned in the surface-contact system, the above notes will not be found without importance, inasmuch as they may aid in an objective criticism of magnetic surface-contact distribution. When arranging for an underground current distribution system the first thing to ascertain is the degree of safety to public traffic the system is likely to offer. On the basis of the experience already gained in the matter, the only systems which meet the case are those with electro-magnetic surface contacts, containing perfect acting safety devices so arranged that the contacts are positively controlled and work sparklessly. This would lead not only to great safety in working, but would also guarantee the safety of the ordinary street traffic, the possibility of the surface contacts remaining alive being totally excluded.

CONTEMPORARY ELECTRICAL SCIENCE.*

ATOMIC WEIGHTS.—J. H. Vincent has discovered a new numerical relation between the atomic weights of the elements. It is

$$W = N^{1 \cdot 21}$$

where W is the atomic weight, and N the number of the element in an ascending series. There are, however, certain gaps in the series which the author allocates to elements yet to be discovered. Hydrogen would, of course, be No. 1. Helium, the next element of the known series, has to be called No. 3, as $3^{1 \cdot 21} = 3.780$, which agrees with the observed value 3.93 within 3.8 per cent. Lithium is No. 5, as $5^{1 \cdot 21} = 7.012$. This leaves gaps for elements of atomic weights 2.313 and 5.352. After lithium, the series is continuous up to No. 60 (samarium), for which $60^{1 \cdot 21} = 147.5$. The remainder of the series up to uranium contains 13 gaps, the atomic weights for which are, in round numbers, 150, 153, 162, 168, 177, 186, 213, 216, 219, 222, 225, 228, 235. If any or all of these gaps are subsequently filled up, the author's formula will achieve a great success. Meanwhile, it is interesting to notice that the greatest deviation from the rule is shown by iodine, whose atomic weight comes out wrong by 3.9 units. But this, as the author clearly shows, may be due to a wrong serial number assigned to it. If it changed places with tellurium, not only would the error be much less, but the periodic law would be better observed.—J. H. Vincent, Phil. Mag., July, 1902.

DISCHARGE FROM HOT METALS.—R. J. Strutt has found that the discharge of positive ions by hot metals can be detected at much lower temperatures than has hitherto been supposed, becoming apparent very far below red heat, and increasing rapidly with the temperature. It will be remembered that, according to W. Wien, the discharge potential at the ordinary temperature and in an "absolute" vacuum is +3,000 volts. The lowest temperature at which the author found a discharge was 200 deg. C. The temperature at which the effect becomes sensible does not appear to depend very largely on the nature of the metallic surface or on the surrounding gas, but, like contact electricity, it alters nearly as much from slight changes in the condition of the surface of the metal, produced by continued heating, as it does when an entirely different metal is substituted. Oxidation appears to be, on the whole, unfavorable to the discharge of the metal. Thus, with a charge of 100 volts, silver showed a leak of 10 divisions of an electroscope scale in hydrogen at a temperature of 228 deg., whereas the same leak required a temperature of 287 deg. when the metal was copper and the gas was air, and 310 deg. when in the latter combination the copper was oxidized and hydrogen substituted for air. The metal was in the form of a wire heated in a gas stove.—Hon. R. J. Strutt, Phil. Mag., July, 1902.

TEMPERATURE AND IONIC SHOCK.—In the field of an electric current the mean velocity of the ions in the gas is greater than that of the neutral molecules. J. Stark points out that the velocity of a negative electron capable of ionizing a molecule is about 1.9×10^8 cm./sec., and that of a positive ion 8.6×10^6 cm./sec. In many electric currents through a gas the mean temperature is only a few hundred degrees above the ordinary. For a temperature of 225 deg. C. the neutral gas molecules of hydrogen would have an average velocity of 3.68×10^5 cm./sec., nitrogen 9.8×10^4, and carbonic acid 7.8×10^4. The ionizing ions move, therefore, from 100 to 1,000 times faster than the neutral molecules, and the latter may, therefore, be regarded as at rest with respect to the former. Anything which reduces the density of a gas, such as reduction of pressure or increase of temperature, increases the free path of the ionizing ions. This implies that the absorption of kinetic ionic energy diminishes with increasing temperature and constant pressure, as noticed in the absorption of Lenard rays by gases. The author makes some interesting applications of this principle to the fall of the discharge potential and to luminous effects in vacuum tubes. Thus the extinction of the glow near a hot body is explained by the increase of the free path, and the consequently lesser absorption of energy from the moving ions.—J. Stark, Ann. der Physik, No. 8, 1902.

RESISTANCE OF INSULATORS.—O. N. Rood, who some time ago prepared a standard resistance of the extraordinary value of 14,000,000 megohms, has made some important measurements of the internal resistance and surface resistance of certain insulators. The main difficulty experienced lay in obtaining a suitable contact between the electrodes and the insulators. Gutta percha was cemented to tinfoil electrodes by a gutta percha solution, and in other cases a soft amalgam of tin was used. The internal resistance of a plate 1 mm. thick and 1 sq. cm. in area was found to be 900,000 ohms in the case of quartz, 18.5 megohms for gutta percha, 55 megohms for ebonite, and 133 megohms for mica. As regards surface conduction, the resistance of 1 sq. cm. between terminals 1 cm. long was found to be 1.6 megohms in plate glass, 22 megohms for cobalt glass, 432 megohms for gutta percha, 521 megohms for quartz, about 2,000 megohms for ebonite and only 51 megohms for mica. It was found that glass has a high surface resistance in comparison with its internal resistance, and in glass condensers it is, therefore, advisable to increase the capacity by increasing the surface rather than by reducing the thickness. More especially, cobalt glass should be used. The author found that his high resistances of last year could be depended upon within a maximum error of some 7 per cent.—O. N. Rood, Am. Journ. Sc., August, 1902.

ELECTRICITY IN RAINDROPS.—A. Schmauss has studied the behavior of a jet of water falling through ionized air. It is known since Lenard that water falling through ordinary air upon a metallic plate communicates positive electricity to the plate and negative electricity to the air. The author finds that on ionizing the air this effect is overlaid by another. The metal plate receives a negative instead of a positive charge, and only after several minutes does Lenard's effect regain ascendency. Zeleny has shown that when a stream of ionized air is directed against a conductor, the latter, owing to the greater speed of the negative ions, acquires a negative charge. In the water jet the conductor is moved against the ionized air, and the effect is the same. Moisture seems to favor the absorption of negative ions. In any case, the explanation of the earth's negative charge is now pretty complete. C. T. R. Wilson has shown that negative ions are more effective as nuclei of condensation than are positive ions. His new experiments, as well as those of the author, show that drops already formed are capable of transporting negative electricity to the earth. It is well to remember that all experiments of this kind are complicated by Lenard's effect, which is probably of an electrochemical nature.—A. Schmauss, Ann. der Physik, No. 9, 1902.

ELECTRON THEORY OF MAGNETISM.—W. Voigt has made an interesting attempt to apply the electron theory to magnetism. The idea that Ampère's "molecular currents" consist of electrons revolving round the remainder of the atom was at once suggested by the Zeeman effect, and the author clothes this supposition in a mathematical form. The result is, however, disappointing in the first instance. It appears that if the electrons are supposed to have a free orbit, then, according to the electron theory, no induced magnetism is possible. The obvious alternative is to suppose that the revolutions or oscillations of the electrons are damped, and this assumption leads at once to a valuable and elegant theorem, which the author formulates as follows: "When the electrons of a body move in a constant magnetic field they produce magnetic effects when their motion (against a resistance) is always interrupted by any irregular impulses, and thus maintained at a constant mean energy. The body will then show paramagnetic or diamagnetic properties accordingly as to whether the motion of the electrons after these impulses shows, on the whole, a surplus of potential or kinetic energy respectively." Such impulses must result from collision with neighboring molecules and electrons, since the electromagnetic heat waves sent out in consequence of such collisions are compensated.—W. Voigt, Ann. der Physik, No. 9, 1902.

* Compiled by E. E. Fournier d'Albe in the Electrician.

TRADE NOTES AND RECIPES.

Carpet Soap.—Adapted for this purpose is a soap which, when dried, is very hard and friable and besides is free from alkali and from fat. Probably only a resin-free, pure soda grain-soap boiled from solid fatty acids or from very hard tallow is suitable as a carpet soap. Its application is accomplished by preparing a concentrated aqueous solution of it, beating a stiff froth, and spreading the same evenly on the surface of the carpet, where it is allowed to dry thoroughly. The water evaporates, and the dry soap particles form a hard top-layer which holds fast the dust on the surface. When the carpet is thoroughly beaten on the back, the soap drops off or may be removed by brushing.—Seifenfabrikant.

Bergamot Leaf Oil.—This oil is little known and has hardly been scientifically investigated as yet. It is contained in the leaves of the bergamot tree in the percentage of only about 0.15, for which reason it is frequently adulterated, at the places of production, with turpentine oil or peel oil. It dissolves in equal parts of 90 per cent alcohol. The bergamot leaf oil, of which only about 20 kilos are distilled annually, is not placed on the market, but is mostly employed for the adulteration of other essential oils, as orange flower oil.—Chemiker Zeitung.

Quick-drying Floor Varnish.—Solution of shellac 1 part in 90 per cent. spirit of wine 2 to 2.5 parts, copaiva balsam 1 to 2 per cent (or Venice turpentine) and a sufficient quantity of umber and ocher. The paint is applied on the wood by means of a shoe brush. An addition of 0.5 per cent of boiled linseed oil to the mass increases its elasticity. When the wood is covered as desired, a coat of clear varnish is finally applied to enhance the gloss.—Farben Zeitung.

Production of Pulverized Milk.—Ekenberg has devised a method and constructed an apparatus by means of which all the evil that heretofore attended the production of pulverulent milk can be avoided. He calls the apparatus a continuous exsiccator. At a temperature not exceeding 40 deg. C. the milk can be evaporated in it to dryness without the use of a vacuum. The powdered milk thus obtained is fine like flour; at the same time the taste and odor of milk are so perfectly preserved that it is possible to tell whether the milk had been pasteurized or boiled. When it is desired to make milk of the powder again, add water and heat to 60 to 70 deg. C., i. e., to a temperature that exceeds the melting point of the butter fat; after the cooling, the milk can be treated like the ordinary article, even with rennet. By a special mode of treatment the author has succeeded, furthermore, to avoid that the milk powder passes upon storing into the insoluble modification; it does not turn sour, and withstands very well the action of bacteria and mold, as well as damp air and increases of temperature. 10 liters of milk give about 1 kilo of powder at the price of 75 to 80 pfennige (18 to 20 cents). The apparatus is easy to feed and readily takes care of 10,000 liters of milk per day. An analysis of powder from skimmed milk has yielded the following result: Albumen, 36 per cent; sugar of milk, 49 per cent; fat, 1 per cent (in the case of rich milk, unskimmed, up to 30 per cent); salts, 7.5 per cent; water, 6.5 per cent.—Neueste Erfindungen und Erfahrungen.

India Ink.—1. Work lampblack—very finely sifted—into a paste with glycerine and a little glue water; subsequently add a little albumen and roll into sticks of about 8 centimeters, which flatten slightly. 2. Make fine lampblack into the consistency of pills with one-quarter glue water and three-quarters glycerine and shape into sticks; if desired, more solvent may be added and the substance filled into bottles.—Pharmaceutische Zeitung.

An Iron Alloy Which is Impervious to Heat.—For many purposes the expansion of the metals, which occurs at increases of the temperature, is a very disagreeable property. We only need to remind of the clock pendulums, which require a special device to compensate this change of volume, and to attain in this manner that the pendulum swings in the like unit of time. With steel rails the expansion of the steel also makes itself felt, so that the fish-joints cannot be made as tight as would be desirable. Latterly, an alloy has been found, whose coefficient of expansion is exceedingly slight; it actually only amounts to one-thirteenth of that of iron. It is a little less than 1-12,000,000 for 1 deg. C., while iron with an increase of 1 deg. C. expands 1-80,000. The alloy consists of iron with 36 per cent nickel, and is excellently adapted for clock-pendulums, etc.—From the German in Neueste Erfindungen und Erfahrungen.

Protection Against High-Tension Electricity.—A coat of mail against the dangers of high-tension electricity has been constructed by Prof. N. Artemieff, teacher of electrotechnics at the Kiew University, and its utility has been convincingly demonstrated in the high-tension laboratory of Siemens & Halske in Berlin. The protection consists in a garment of fine close brass gauze, which envelops the body entirely, including the hands, the head and the feet, so that the current, if it should pass over to the body, will only get as far as the metallic surface and is conducted off on the same. Among others, Prof. Artemieff, wearing his protective garment, touched conduits, carrying an alternating current of 150,000 volts at 50 periods, and established through his body, i. e., through his clothing, a short circuit between two poles having a tension of 1,000 volts, causing a short circuit current of 200 amperes, which was perceptible to the experimenter merely by a slight sensation of warmth.—Neueste Erfindungen und Erfahrungen.

Plastic Graining of Wood.—A process to cause ornaments and veining to stand out plastically on wood surfaces is the subject of a German patent. The portions of the wooden surface which are to be in relief are covered up, stencil-like, with glue-soaked paper in the well-known manner. Then the whole surface is treated by means of bundles of fine steel wire, which are dabbed down in a vertical direction. In this manner the soft wood between the firm wood veins is fetched out dust-like, while the so-called firm annual rings and the glued-on size paper remain standing.—Allgemeine Tischler Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Arabic Typewriters.—On numerous occasions, this office has been asked to encourage manufacturers in the United States to make an Arabic typewriter. I have done so, both by personal representations and in writing. There are millions of people in western Asia, northern Africa, India, and elsewhere who would be benefited by such an invention. It is therefore exceedingly gratifying to learn that, after many experiments, a concern in the United States has finally been able to place on the market a suitable machine. In Egypt, the new Arabic typewriter was turned over to a committee of six experts for criticism and examination. In this connection, the following extract from a reliable newspaper report is submitted:

"Four of the committee were chosen as being experts in Arabic writing, while of the others one was a government official and the other an English examiner in typewriting. Hitherto the greatest difficulty has been experienced, first, in allowing certain letters double the space of the others and, second, in providing certain letters with three different forms, according as they are at the beginning, the end, or in the middle of a word. The machine contains 84 characters, and 8 of these automatically supply themselves with double the space of the others. The machine, for compactness and facility in working, is equal to any European machine, and it is calculated that with little practice, any ordinary person can easily acquire a speed of 45 words per minute, which would correspond to about 60 words per minute in a European language. The writing is of extreme facility to read and presents a very neat and symmetrical appearance. The joinings of the letters are perfect. The opinion of the Arabic handwriting experts was that the writing was good, but that several letters could be more elegant. An English idea of writing is naturally based on simplicity and facility in reading, but handwriting to be perfect from an Arabic standpoint must be pretty or even ornamental. The machine has doubtless come to stay, and is now being shown at the various government offices."

There will be immediately a great demand for the Arabic typewriter, and before long, I take it for granted, several concerns in the United States will be manufacturing and exporting Arabic machines. As agents in Syria, I would mention Mr. Michel Nasser and Messrs. B. Audi & Co. (Beirut, Syria, English mail via London).—G. Bie Ravndal, Consul at Beirut.

Popular American Wares in England.—Furniture.—Trade in United States furniture is developing in Nottingham. The largest furniture house in this section—with a retail stock filling several stories, and operating an extensive factory—has just imported household goods from the United States, which are likely to find a great sale, if one may judge from the admiration which their style and make elicit from persons who view them.

The firm has for years had a large trade in American office furniture. A member of the firm recently remarked to me: "I regret to say, as a patriotic Englishman, that 90 per cent of the office furniture we sell is American." Roll-top desks are in special favor. Sporadic attempts have been made to make them in England, but, I am told, with such poor success that they have ceased, the Englishman being unable to compete with the American in styles and prices. The rules of the trades unions seriously hamper cheap production in this country. Though wages are nominally lower than in the United States, they are in fact higher, if anything, considering the work actually done, under the British workman's theory that to prolong a job by doing it slowly makes more work. Under the operation of the trades-union rules, the slowest worker sets the pace of his associates, no matter what their number may be.

Corsets.—American corsets rule this market. Dealers tell me that they eclipse the Paris styles, and that the French makers are, perforce, now getting their patterns from the United States.

Shoes.—This city supports a thriving American shoe store. The stock is made in the United States expressly for the English trade and the English foot, and the narrower American foot is not easily fitted therefrom. The women's shoes are made from American calfskin or the like; the men's are of English horse leather, sent from this country and made up in the United States. This is to supply the demand for water-tight shoes. Rubbers are but little worn here, though the American shoe store is trying to create a demand for them.

Cooking Utensils.—An American roaster, for cooking meats so as to retain their juices and rendering basting unnecessary, is in high favor and has a great sale here; also an American "egg steamer," of which a hardware dealer states he can not get supplies fast enough to satisfy the demand.

These are instances which I have accidentally observed. Doubtless they could be multiplied, but there is still much opportunity for the extension of our trade in this locality. These cases not only show that American goods are used in large quantities here, but encourage efforts to extend our trade along new lines.—Frank W. Mahin, Consul at Nottingham.

American Manufactures in Chemnitz.—To what extent articles of American manufacture have already invaded the Chemnitz market is well illustrated by the line of our goods on sale at a local store, that of Bargou & Sons. American lead pencils and penholders of diverse kinds are to be found there; chief among this class of goods are fountain pens, which are retailed at a price ranging from 50 cents to $2. These pens, it seems, can be bought more cheaply in the German market than in America, the reason apparently being that American manufacturers make their profits in the United States and sell abroad at a price that wins and holds the trade. Beautifully mounted American gold pens are to be had at various prices, up to $2.50.

Other articles of American make are puzzles made of cast iron, retailing at from 5 cents to 10, 20, or 50 cents; kites, of the square variety, made of paper, and shipped folded together, retailing at from 3 to 20 cents; phonographic rolls; perforated seat boards for chairs, retailing at 5 cents; glass cutters, retailing at 10 cents; tack hammers, at 10 cents; fly killers, with wooden handles and steel brushes, at 10 cents; cream beaters, at 10 cents; and various classes of pictures intended for decorative purposes, retailing at the low figure of 60 cents.

The perforated seats for chairs are also said to be imported to a great extent from Russia. The perforations take the form of decorative designs, and the wood is about one-third of an inch in thickness.

From the above list, it will be apparent to the American manufacturer that profitable business can be done in the exportation of articles of low market value. Articles like kites, of which thousands occupy but a comparatively small space when packed, and light chair seats incur but a slight transportation charge. The importation of kites is, according to the statement of a local business man dealing in this article, rapidly falling off, because of the neglect of the American manufacturers to protect themselves in Germany with a patent covering this particularly popular kite. German manufacturers are said to have at once taken up the production of the American kite and are now holding the larger part of the market. This trade incident ought to teach our manufacturers a lesson in the necessity of promptly protecting their trade interests in foreign countries by patent rights, and guarding against their imitation by German manufacturers.

The local retail houses handling American goods of course do not import directly, except in very rare instances where such an extraordinary demand exists for certain goods as to warrant the direct shipment of large orders. As a rule, the large importing houses located at Hamburg, Bremen, Berlin, and other advantageous trade points act as distributing centers and supply American stock in small quantities on short notice.—J. F. Monaghan, Consul at Chemnitz.

Export of Timber from British Columbia Prohibited.—In Advance Sheets of Consular Reports No. 1,470, issued October 16, 1902,* a report of mine was published regarding the lumber industry in British Columbia, in which I made the statement that an export duty had been placed upon timber cut upon the public lands of this Province. The information upon which I made that statement was derived from the newspapers of this city, but my attention has since been called to the fact that it is not an export duty, but an absolute prohibition placed by the government upon the export of timber cut upon lands owned by the Province.

Timber off all unsurveyed and unpre-empted Crown lands can be cut either under 21-year leases or annual licenses. During the session of 1901, an amendment to the then existing land act was passed, reading as follows:

"All timber cut from provincial lands must be manufactured within the confines of the Province of British Columbia, otherwise the timber so cut may be seized and forfeited to the Crown and the lease canceled."

The point was raised that the above only applied to leases, not licenses. In July, 1902, an order in council was made to make the above restriction apply to licenses.—L. Edwin Dudley, Consul at Vancouver.

Austrian Navy as an Aid to Commerce.—In addition to various other enterprises for increasing Austro-Hungarian exports, it is of interest to note that the "Zenta," one of the vessels of the Austro-Hungarian navy, lately commissioned for a year's cruise, has been, in a measure, rendered available for purposes of commercial investigation. The "Zenta" will visit the chief ports of Africa, several important island groups, as well as Uruguay, Brazil, and the Argentine Republic. An experienced officer of the Austro-Hungarian consular service has been detailed for duty—with the consent of the marine section of the Ministry of War—to accompany the vessel on her cruise, in order to study the trade conditions of the countries visited and make reports to the government, with the ulterior object of increasing the exports of Austro-Hungarian products to the districts in question. Although towns may be visited where Austro-Hungarian consuls are stationed, a general survey by a competent commercial specialist can not fail to be fraught with good results. It will be seen that no special legislative appropriation is necessary to render this kind of commercial exploration possible. The plan is eminently practical and well worthy of attention.—Carl Bailey Hurst, Consul-General at Vienna.

American vs. European Trade in Cuba.—The Department is informed that dealers in Cuba in machinery have a decided advantage in placing their orders in Europe instead of in the United States, because in the actual condition and state of affairs they get (1) lower prices, varying from 10 to 30 per cent, according to class of machinery and materials; (2) lower shipping rates; (3) quicker delivery; and (4) terms of payment more advantageous, as European manufacturers are willing to sell their goods on time, while American manufacturers want cash. It is stated that even in case a large reduction of duty, preferential to the United States, should be conceded by Cuba on the articles referred to, the lower prices and freight rates, quicker delivery, and easier terms of payment would fully compensate for the higher customs duties that Cuban dealers would have to pay on the European machinery and materials.

Japanese Enterprises and Foreign Capital.—Under date of October 23, 1902, Consul S. S. Lyon, of Kobé, sends the following newspaper clipping:

"During the past few months, several municipalities and companies in Japan have applied for foreign loans. Among those who have successfully concluded negotiations is the Yokohama municipality, whose 6 per cent bonds to the amount of 900,000 yen ($448,200) were recently undertaken by Messrs. Samuel Samuel & Co. The same firm also undertook the issue of the Osaka harbor works bonds, to the amount of 3,500,000 yen ($1,743,000), and it has been agreed to issue further bonds for 6,500,000 yen ($3,237,000) a year hence. The Tokyo Gas Company also proposes to introduce foreign capital for the extension of its business, and negotiations are proceeding with Mr. Tison, representative of Mr. Brady, of New York. When Baron Shibusawa returns from Europe, it is expected these negotiations will be completed, half the amount of the capital being in American hands.

"As is well known, the Kiushu, Hokuyetsu, and Hankaku railway companies recently applied to Messrs. Baring Brothers, through Messrs. John Birch & Co., for a loan, their application resulting in the visit to this country of Sir William Bissett. A vernacular contemporary says that an inspection of the systems of the companies revealed the imperfections of Japanese railways, and also the barriers placed by the law against the introduction of foreign capital. The beneficial result of Sir William's visit is that the laws are being amended and in consequence, it is reported, the negotiations with the English capitalists are progressing favorably."

Demand for Traction Engines in Johannesburg.—Consular Agent W. D. Gordon writes from Johannesburg, October 8, 1902:

I believe that the call for traction engines in this country will be a considerable one, and our manufacturers interested in this line should make an effort to secure the business. The country has been practically stripped of draft animals, and it will be many years before the requirements in this line will equal the demand. If manufacturers will forward this office catalogues, price lists, weights, discounts, etc., I will endeavor to place them in the hands of interested parties. An inquiry has just been received for a corn cleaver and corn mill, to be operated by a traction engine. Several of these can be sold.

American Machinery in Syria.—American machinery has finally invaded this country. As yet, only the advance pickets are here, but they promise to hold the ground. It is chiefly along agricultural lines we are progressing. I have already noted the advent of American windmills to these regions.* I am now able to state that this year, for the first time, reaping machines have been employed by native farmers. These pioneers all came from Chicago. Eleven were working, during the late harvest, in Cœle-Syria and 26 in the plain of Esdraelon. Also, for the first time in the history of this country, the present year has witnessed the introduction and operation in Syria of a steam thrashing outfit. It came from Richmond, Ind., and caused considerable stir in Cœle-Syria, where it was installed. Its success was complete, even to the bruising of the straw—a most important item, since, in the absence of hay and with the sparing use of oats, barley, and other grains, crushed straw, in these parts, constitutes the staple food for stock. Furthermore, for the first time in the annals of Syria, an oil-motor flour mill has been successfully started in this land; it came from Indianapolis, and is now grinding wheat in Lebanon. It will soon have many colleagues, owing to the scarcity of water power. Among late orders from the United States, not yet filled, I would mention a steam plow for Cœle-Syria and 80 walking plows for the Haifa district; also, some hayrakes and mowers, forks, hoes, harrows, land rollers, cultivators, pumps, and petroleum engines besides a few farm wagons.

Mr. Michel Nasser, of Beirut, Syria (English mail via London), backed by H. Sabbag et fils, has assisted greatly in bringing about this change in agricultural methods, which promises a radical improvement in the economic condition of Syria and Palestine. American manufacturers are referred to Mr. Nasser. Other importers are: B. Audi & Co., Beirut; A. Duck & Co., Haifa; E. Luttiche & Co., Damascus; John Hakim, Tripoli; Phares Behannesey, Zahleh; and Mohammed Dada, Sidon.

Agricultural machines and implements are admitted into Turkey free of duty.—G. Bie Ravndal, Consul at Beirut.

Demand for Portable Houses in Cape Colony.—Consular Agent W. D. Gordon, of Johannesburg, under date of October 15, 1902, says:

As this country has been devastated of buildings from one end to the other, and as a largely increased population is already here or en route, our manufacturers of portable houses should be able to secure considerable business. Building material is very high and arrives from the coast very slowly. Any information sent me on the subject will be placed in interested hands.

Prices of Ice in Colombia.—Vice-Consul-General Felix Ehrman writes from Panama, November 1, 1902, that the price of ice has been raised from 5 cents Colombian silver per pound to 12½ cents Colombian silver per pound. This makes the price about 5 cents United States gold per pound. The cause of the increased rate is that the Colombian government has raised the price of the monopoly, and the ice company had to raise their charges.

* Consular Reports No. 267 (December, 1902).

* See Advance Sheets No. 642; Consular Reports No. 234.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

UNDERGROUND WIRE ROPE HAULAGE.

WIRE rope haulage systems may be arranged in three general classes. First: The Inclined Plane, which consists simply of a slope on which the load is raised or lowered by winding and unwinding the rope on a drum. This system is naturally limited in its action and can in no sense be considered capable of general application. Second: The Endless Rope System.—This consists of a wire rope spliced endless, working over a drum located at any point of the haul. The rope is kept tight, and by means of special grips the load may be attached or detached at any point. As applied to a single track, the motion of the rope is reversed for the return of an empty train, but by means of a double roadway, the load may be received on one track and returned on the other, the rope moving in one direction only. Third: The Tail Rope System.—This consists of two ropes winding on separate drums which may be located at different points, but which generally work on the same shaft.

The "main" rope runs along the ground and is attached to the front of the loaded train. The "tail" rope is supported along the walls or roof of the tunnel, extending to the end of the haul, where it passes over a return wheel, and is returned along the ground, being attached to the rear of the train. The main rope is then wound on its drum, hauling the load followed by the tail rope. For the return trip the motion is reversed, the tail rope is wound on its drum and the empty cars are drawn to the end of the haul, dragging the main rope.

Of the endless and tail rope systems, the latter is capable of more general application. The endless rope must be kept constantly tight, necessitating heavier rope and causing greater friction on its supports. Less rope is required than in the tail rope system, but the added expense for mechanical treatment more than offsets the saving. Curves and entries particularly, are sources of difficulty.

There are very few conditions under which the tail rope system, properly handled, does not exhibit its advantages. It is easily applicable to a straight or curved run of any length and of any variation of grade, and side entries may be worked as easily as the main tunnel. The general introduction of the system is due to the Broderick & Bascom Rope Company, of St. Louis, Mo.

The tail rope system has been in operation in the workings of the Coal Valley Mining Company of Sherrard and Cable, Illinois, for twenty years.

The mine at Cable is the older of the two controlled by the company. A number of years ago it was abandoned as incapable of further output on a paying basis, under old methods. A tail rope system extending into the workings for a mile and a half was the means of immediately doubling the output at one-half the cost of the old operations. To-day the mine is being drawn and the haulage system extends about 5,500 feet along the main tunnel. A feature of this tunnel is the heavy grades. From a practically level run of 1,500 feet, there is an undulating fall of 45 feet in 2,000, followed by an equal rise in 1,000 feet. The grade varies greatly, reaching a pitch of 10 per cent in places. The main rope is one inch in diameter, the tail rope three-quarter inch, both of six strands with nineteen wires to the strand, with a hemp center. The regular haul is twenty cars carrying one ton each, the weight of the cars averaging 850 pounds. They are delivered at the bottom of the shaft, hoisted, and dumped.

The hauling machinery is located above ground, the ropes running over sheaves down the shaft and into the tunnel. A pair of 12 by 16 inch engines aggregating 75 horse power is used, working the same shaft.

The Sherrard field is of such a nature as to make operations desirable in all directions from the main shaft, differing in this respect from the field at Cable, the latter extending in one general direction with no great width.

The engine room is located near the bottom of the main shaft. Its equipment consists of a pair of 12 by 18 inch, 40 horse power engines, working main and tail rope drums for the south tunnel, and a pair of 8 by 10 inch, 25 horse power, for the north. The drums are 48 inches in diameter, provided with 20 inch paper friction rollers to aid in gradual starting and stopping. The necessity for the larger engines for the southern haul arises from the profile; the heavy grades are met with cars loaded, while to the north the grade is mounted with the empty train.

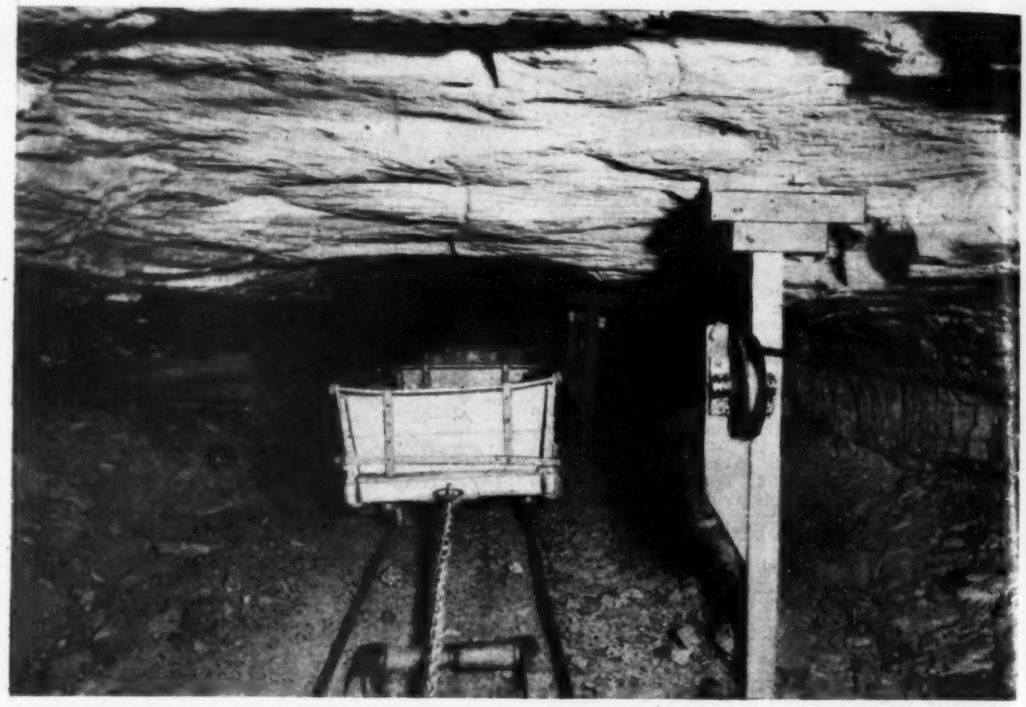
The loaded cars are hauled to the main station, and there weighed and switched to the coal hoist, where they are dumped. A feature of the workings is the automatic coal hoist. The coal is dumped into a hopper at the bottom of the shaft, the descending box loading from it automatically. A reverse action at the top of the hoist dumps the coal on the screens. By this means the necessity for hoisting the cars is obviated.

The north tunnel and side entries are equipped with three-quarter inch main and tail ropes, with the exception of the east entry. The grade brings the entire pull of the loaded train on the tail rope, and a one inch tail rope is used for this entry. The south tunnel and entries have one-inch main and three-quarter inch tail ropes. All ropes are of six strands with nineteen wires to the strand, with a hemp center.

The main rope runs on rollers fixed between the rails at intervals varying from ten to sixteen feet. The rollers are of maple, four inches in diameter and eighteen inches long on seven-eighths inch iron axles. The axles have a bearing in cast-iron keyed journals set in three by four inch blocks. By occasionally reversing the rollers between bearings and shifting the blocks, the wear caused by the rope is distributed over the roller, prolonging its usefulness.

The tail rope is supported along the side of the tunnel on ten-inch cast-iron sheaves supported on brackets of four by six-inch oak, wedged tightly between the floor and roof. Binding sheaves are used at intervals to prevent the rope leaving its support under sudden strains or on account of any lifting tendency at the foot of a slope.

On curves, or at points where it is desirable to carry either rope across the track, a series of horizontal cast-iron guiding sheaves, six inches in diameter, is used.



THE HEAD OF A TRAIN IN THE MAIN TUNNEL OF THE SHERRARD MINE, SHOWING CHAIN CONNECTION, A WOODEN ROLLER, AND THE METHOD OF SUPPORTING THE TAIL ROPE.

The return wheels at the end stations are cast iron sheaves 48 inches in diameter, set vertically, secondary 30 inch wheels being used to lift the return rope to the roof of the tunnel.

On curves a special arrangement is introduced to carry the main rope. The side pull is resisted by a series of wooden drums, 30 inches in diameter, set on vertical axles with their nearest points about eighteen inches from the inside rail to allow room for passage of the cars. These drums are of barrel form, built up of alternate staves of maple and pine. The rope may run on the ground rollers placed beneath the drum while the train is some distance from the curve, but as the load approaches, the rope is drawn against the drums.

In working up a side entry, the ends of both main and tail ropes of the side line lie conveniently near the outer end of the entry. The ropes of the main line are brought to the proper position and uncoupled. The ends of the side ropes are substituted and the entry ropes run as continuous with the main line. The coupling used is the invention of Mr. Robert Lee, and is a model of convenience and practicability.

By bending in the direction of the slot, and taking up an inch of slack, the swivel is released. A reverse process makes the connection, the entire operation being performed by one man. The swivel feature is particularly valuable in removing any twisting strain due to the motion of the rope.

The ropes are attached to front and rear of trains by means of clevis couplings, a short length of chain being used next the cars to aid in taking up any slack. At the rear of the train a special knock-off hook is used instead of a clevis pin, to aid in uncoupling with a strain on the rope.

When mounting grades a safety device known as a "drag" is used. This is simply a sharpened iron bar attached loosely by one end to the rear of the train so as to drag freely on the ground. In case of any sudden breakage or slackening of the rope, the point of the drag is driven into the ground by the weight of the train.

The commonest argument used against wire rope as a medium for underground haulage, is its rapid deterioration. The argument has no foundation if certain common sense principles are applied in properly caring for the rope and reducing friction to a minimum. In the workings described, there is rope in use to-day which has been worked constantly for more than eight years, the amount of deterioration being inappreciable.

The rope is never allowed to touch the ground while running. The wooden rollers are so placed as to effectually prevent this occurring, even for a short time. Mine dust, mud, and water have a much more injurious effect than the same elements above ground, owing to their powerful chemical properties.

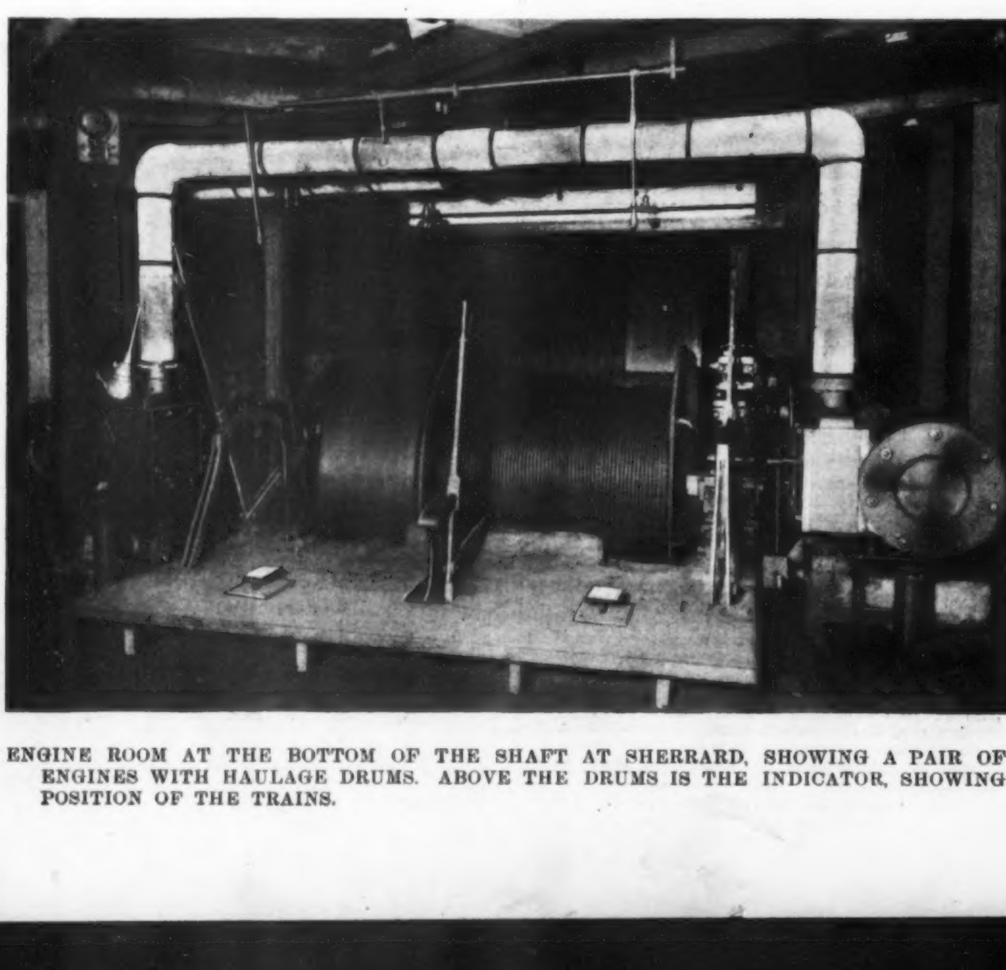
The entire rope, including the hemp center, is kept constantly lubricated and never allowed to work "shiny." The rope grease is applied with a brush, it having been found that better penetration between the wires is obtained in this way.

Careful provision is made for gradual stopping and starting, thus avoiding sudden jerks. The ropes are kept taut while running to avoid kinks or twists.

All drums and return wheels are large enough to keep the bending well within the limit of flexibility of the rope.

The "tunnel" end of the rope undergoes more hard usage than the "drum" end, so the entire rope is reversed after a time in order to distribute the wear.

Friction is reduced by using large sheaves. Carrying



ENGINE ROOM AT THE BOTTOM OF THE SHAFT AT SHERRARD, SHOWING A PAIR OF ENGINES WITH HAULAGE DRUMS. ABOVE THE DRUMS IS THE INDICATOR, SHOWING POSITION OF THE TRAINS.

sheaves are all 8 inches in diameter, and ground sheaves 6 inches. These sizes are greater than necessary for the mere support and guidance of the rope, but their greater circumference reduces the number of revolutions and consequently the friction and wear on axles and journals. Return wheels and curve drums are also made as large as practicable.

COMMERCE OF THE GREAT LAKES.

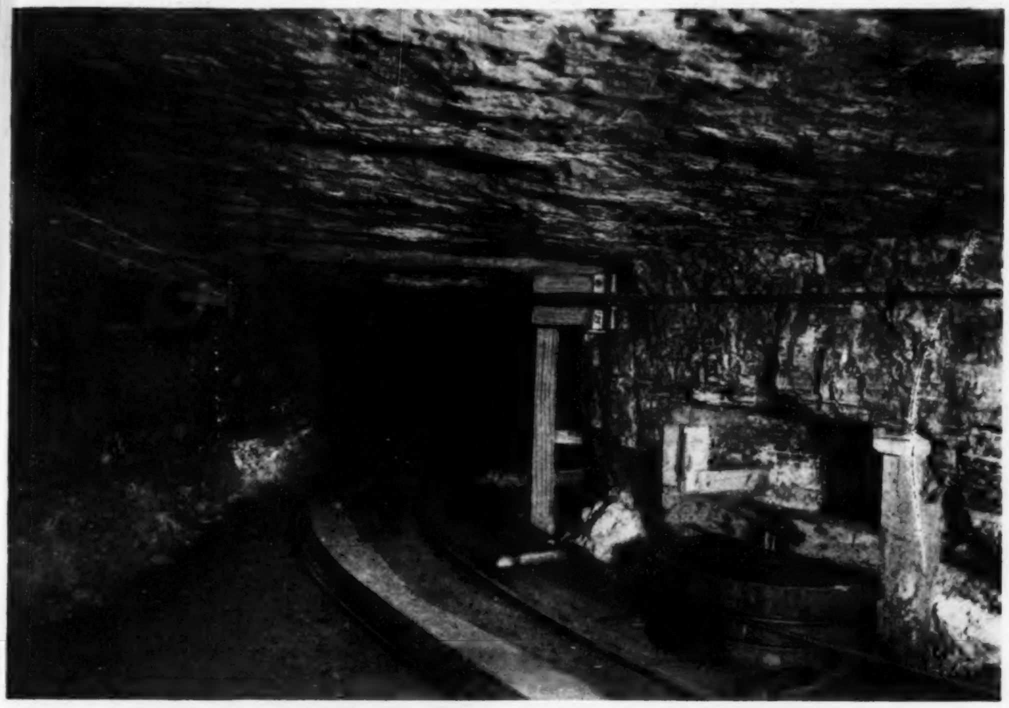
THE phenomenal activity of the whole country is illustrated by some figures, just prepared by the Treasury Bureau of Statistics, showing the commerce on the Great Lakes during the month of July and the seven months ended with July. The chain of Great Lakes, which stretches from New York at the east to Minnesota at the west, transports a large proportion of the products of a dozen States in which are included the principal agricultural, mining and forestry sections of the country. The measurement of the commerce of the lakes, therefore, is an important exponent of the business activities of the country. This is accomplished by the figures of the Treasury Bureau of Statistics, which show that the total freight receipts at 144 receiving ports on the lakes were 25,718,826 net tons in the first seven months of the year, compared with 18,891,257 net tons in the corresponding months of last year.

The statistical measurement of trade on the Great Lakes has been greatly developed by the Bureau of Statistics within the last few years. Under the system of reporting cargo by masters of vessels, which it established in the year 1900, an average of from 7,500 to 8,000 supplementary manifests is received at the bureau each month during the season. These manifests are immediately tabulated in such a manner as to show the amount of business done by each lake port throughout the month and year. July is the latest month for which figures have been published in the summary of internal commerce, 144 receiving ports and 217 shipping ports being represented.

The end of July usually marks the turning point in the open season of lake navigation. This year, however, an earlier opening brought out much heavier tonnage movement than last season. The total freight receipts for the first seven months of this year were 25,718,826 net tons, as against 18,891,257 net tons to the corresponding date last season. This increase is at the rate of 30.6 per cent over the received tonnage last season. Shipments thus far this season have amounted to 26,876,006 net tons, those of last season being 19,653,334 net tons. The most conspicuous gains have been made in the shipment of ore and minerals, not including coal, this season's total amounting to 13,377,912 gross tons, against only 9,083,982 gross tons in 1901—a gain of 47.3 per cent. Coal shipments increased from 3,670,871 net tons last season to 4,652,323 net tons this season. Slightly less than half of the total freight tonnage on the lakes consists of iron ore.

The movement of registered tonnage of vessels on these inland waters is reported for the first time this year. In these reports of internal commerce only the vessel movement between American ports is included. In seven months 37,413 vessels arrived, with a tonnage of 35,087,876 tons registry, and 37,798 vessels cleared, of 35,786,701 tons registry. This is more than twice the registered tonnage of both foreign and American vessels engaged in the foreign trade of the country, for the same period of time. The foreign trade engaged 2,174,954 tons of sail, and 14,094,967 tons of steamships of all nationalities to July 31, 1902, making a total of 16,269,921 tons. The combined registered tonnage in the foreign trade at New York, Boston, Philadelphia, Baltimore, New Orleans, San Francisco and Puget Sound for the entire year 1901 was 18,868,808 tons entered, and 18,487,246 tons cleared, or somewhat more than half the total tonnage reported for the Great Lakes during the seven months of 1902.

Further analysis of this enormous total shows that fourteen ports each report arrivals and clearances of a million tons and over. Five ports—Chicago, Milwaukee, Duluth, Cleveland and Buffalo—each show clearances of two million tons and over. The combined arrivals at these five ports was 11,421,099 tons, and the clearances 11,455,544 tons.



THE SPECIAL ARRANGEMENT FOR CURVES, SHOWING A HORIZONTAL GUIDING SHEAVE AND THE POSITION OF THE ROPE WITH A TRAIN APPROACHING.

THE ARTIFICIAL PRODUCTION OF PRECIOUS METALS.

FOR over one thousand years mankind declared and believed that gold and silver could be artificially produced, and innumerable searchers have labored on this problem. These workers have not been wholly within the class of metallurgists or what we might call scientists, but all ranks and callings have contributed contingents. The general impulse which we designate as alchemy remained influential until the beginning of the eighteenth century, and was so widespread that it deserves consideration by a student of social science. While it is probable that in the more ignorant ages a larger number of people believed in incantations and ghosts than practised true alchemy, yet the public profession of the latter was much more frequent than the public profession of supernatural powers. The history of alchemy has indeed less significance for chemistry than for the history of culture.

The belief in transmutation was promoted by the observation of cases in which the appearance of gold and silver could be imparted to baser metals. For example, copper alloyed with zinc assumes the ordinary color of gold. Treated with certain arsenical substances it assumes a silver-like appearance. Moreover, the doctrine of Aristotle that substances differ, not because of different composition, but by reason of difference of properties, necessarily encouraged the transmutationists. It was in this spirit that one operator distilled mercury 1,700 successive times in hopes of driving out from it the liquefying principle and thus obtaining the solid silver.

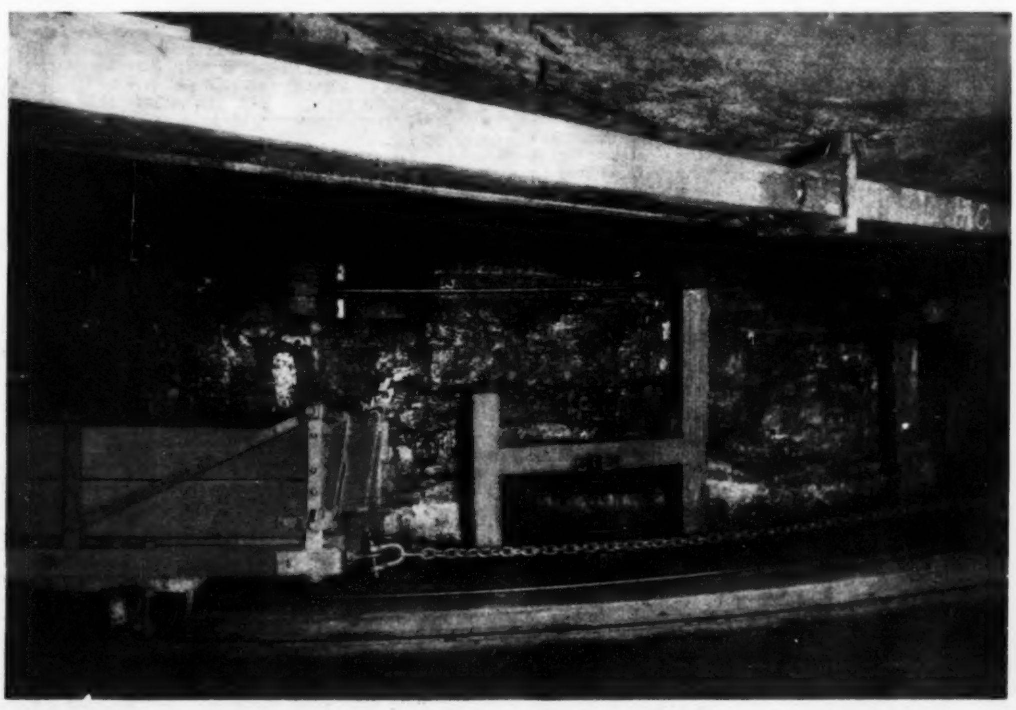
This ignorance as to the details of chemical composition also led to another misunderstanding. Mine waters containing copper compounds (the existence of copper as such in the water was not recognized) would, by the action of iron, deposit the copper and the iron would dissolve. We have no difficulty to-day in comprehending the nature of the action, but there was a time when it was believed to be a transmutation, and in alchemical language was expressed as being due to Mars (iron) having laid off his armor and decorated himself with the garments of Venus (copper).

It is interesting to note also that according to the Greek alchemists lead was the generator of other metals. It was especially the generator of silver. We have no difficulty in understanding how this last error arose. Lead ores usually contain some silver, often very considerable amounts, and the operation of cupellation easily burns off the lead and leaves the button of silver, in which small amounts of gold are often found.—Henry Leffmann in Cassier's Magazine.

CLEOPATRA'S EMERALD MINES.

A JOURNEY of exploration to what are known as the emerald mines of Cleopatra is described by D. A. MacAlister in the new number of The Geographical Journal. They lie in the mountain range that extends for a long distance parallel to the Red Sea, and a few leagues west of its coasts, in a latitude rather south of Eofu, on the Nile. This, like some other parts of the region, such as the porphyry quarries of Jebel Dokhan, was far better known than it is now, and more thickly peopled, about twenty centuries ago, and only during the present one, so far as we know, have isolated explorers, at long intervals, found their way into the treasure house of ancient Egypt. When its rulers first used the emerald for personal adornment is uncertain. Whether the large, clear green stones which, according to ancient authorities, ornamented the Egyptian temples, were really emeralds is a matter of dispute, but as this gem—owing to its regular shape, which is commonly a six-sided prism—and its beautiful tint stands less in need of the lapidary's art than many others, it probably formed part of the regalia of princes at a very early period. That it was known to the Romans is certain, and the mines now revisited used to send their treasures to the gem cutters of the capital. Ever since then the stone has been highly esteemed. In the Middle Ages few jewels commanded a higher price, for, in addition to its beauty, fancy endowed it with medicinal virtues. It was prophylactic against epilepsy and a cure for dysentery. Like the sapphire, it guarded the chastity of the wearer, and resented any trespass by breaking into pieces. Though a more prosaic age has divested it of these virtues, it is still highly valued, nor do we contemn its less brilliantly colored relative, the aquamarine, or beryl, which is practically the same mineral, the tint of the emerald being due to the presence of a small quantity of the metal chromium.

These mines of the northern Etbai seem to have remained untouched since the decline and fall of Rome caused them to be deserted. According to Mr. MacAlister, the workings are only small passages, hardly more than burrows, excavated in the emerald-bearing schist, and sometimes extending for a long distance. Many scattered ruins may also be seen—dwellings, watch towers and tombs, besides those of fen settlements. In these, no doubt, the mining population used to live, and the differences in style suggest they were occupied for a long time. Some are mere hovels, very roughly built; others show a more careful construction; while a third group are well finished. Mr. MacAlister also found three rock-cut temples, for the soft stone lends itself to that kind of architecture. He thinks that their pillars, though very primitive in style, indicate Egyptian designs, with traces of Greek influence; one, indeed, contains a crumbling inscription in that lan-



ANOTHER VIEW OF THE CURVE ARRANGEMENT. THE HEAD OF A TRAIN ROUNDING THE CURVE.

guage. Broken pottery, sometimes ornamented, is abundant, but there is no evidence that the neighborhood attracted visitors for any but business purposes.

Notwithstanding this, there was in those times a settled instead of a nomad population, and travelers once must have been rather frequent, for in one place many drawings of persons, animals and tribal marks are scratched upon the rocks. The subjects are various enough, family scenes and fights—in which the weapons are swords and spears, bows and arrows—camels and dromedaries, horses, dogs, goats and oxen, besides ibex, gazelles and ostriches. Some of the figures evidently are much older than others; but, as a whole, they recall to memory the Sinaitic inscriptions which some forty years ago were believed to be memorials of the wanderings of the Israelites. To this attractive hypothesis the late Professor E. H. Palmer gave the death blow, when he demonstrated them to be—as, no doubt, are these of the emerald mines—only the graffiti of travelers, none of them, probably, earlier than the Christian era.—London Standard.

WATER TUBE BOILERS.

By the English Correspondent of the Scientific American.

I.

Are water tube boilers more advantageous than cylindrical boilers for war-vessels? For the past ten years a fierce and animated discussion has raged among the naval experts of the great maritime nations of the world, regarding the relative merits of the two types of boilers, and opinions are pretty evenly divided upon the subject.

France was practically the pioneer in this new system of steam generation, and was the first nation to introduce the water tube boiler in warships upon a sufficiently large scale to enable comparative data regarding the two types of boilers to be obtained. As is well known, the boiler selected by the French Admiralty was the Belleville, and was the outcome of several years' investigation and research by its designer.

This invention completely revolutionized the process of steam generation then in vogue. Instead of the gases from the furnaces playing through tubes surrounded by water, a diametrically opposite principle was adopted. The tubes were utilized for containing the water, and the heated gases played around them. It was conceded that by this process steam could be raised much quicker, greater steam pressure could be obtained, with a consequent increase in the speed, and what was still more important, enhanced speed was attained without any increase in the consumption of fuel and water. Also the Belleville boiler occupied less space than the cylindrical boiler, which was another great recommendation in its favor. In other words, the Belleville boiler was conceded to be more economical in the consumption of fuel and space than the ordinary cylindrical boiler.

The preliminary experiments by the French government were followed closely by all naval experts and marine engineers, and the claims of the invention were realized with conspicuous success. The English Admiralty, impressed by the success of the boiler upon the French vessels, immediately decided to introduce it into the British navy, since its advantages were conceded to constitute a most vital factor in the efficiency of a warship, where the success of a battle often depends upon raising the steam to the maximum pressure in the minimum amount of time. With the cylindrical boiler, full steam must be maintained in anticipation of the psychological moment. The experiences of our warships off Santiago during the war with Spain emphasized this imperative exigency. Steam had to be kept up on this occasion, at enormous fatigue to the men, expense, and considerable wear and tear upon the machinery. Admiral Melville, in the course of his report upon this engagement to the Society of Naval Architects, said: "The battle of Santiago has established the necessity of water tube boilers. It would have been of great advantage to us to have possessed boilers capable of raising steam in less than 1½ hours. We should have saved much coal." He also pointedly remarked, "I feel sure that the 'Colon' would not have got so far if she had not had multitubular boilers."

The British Naval Department, however, have not experienced the success with the Belleville boiler that was anticipated. It was ten years ago that it was first introduced, and during this period the department has been roundly abused for embarking so extensively as it did upon an enterprise which was characterized as being only in its experimental stage. Certainly this censure has not been due, as has often been described, to conservative opposition to an innovation, for incessant trouble has been experienced with all vessels with this type of boiler, and it is a mooted point whether, in actual warfare, the warships fitted with the Belleville would not fail at the crucial moment. Breakdowns of the machinery are constantly occurring, and the matter reached such a crisis that, a few months ago, the government appointed a special committee, consisting of the foremost naval engineers of the country, to investigate the Belleville; to ascertain its qualities as to being the best type of marine boiler; to compare it with other water tube boilers; and finally to discover whether, after all, there are any real and permanent advantages accruing from the water tube over the cylindrical boiler.

The report of this committee has now been presented to Parliament, and the Belleville boiler has been unanimously condemned. Nor has the employment of any water tube boiler in its entirety been recommended, though at the same time the cylindrical boiler, owing to the present advanced stage of marine engineering, is not conceded to be the best all-round marine boiler. But a combination of the two types is suggested, one fifth cylindrical and four-fifths water tube, by which means it is anticipated that the most salient advantages of the cylindrical and the water tube respectively may be obtained. All the new first-class cruisers now under construction are to be fitted with this combination.

The Belleville boiler belongs to what is called the "foaming" class. This epithet is not applied as a mark of disparagement in any way, but simply to distinguish it from the "drowned" class. The difference between the two is that, whereas in the "foaming" class the tubes deliver the steam above the water level in the large steam drum, in the "drowned" type the steam is delivered in the drum below the water line.

The arrangement of the Belleville boiler consists of a large transverse drum with a number of "elements" depending from it, each element consisting of a number of straight tubes of large diameter, coupled together so as to constitute a continuous zigzag tube, from the bottom immediately over the fire to the point of delivery into the drum; the tubes from the element reach from back to front of the boiler. Water is brought to the bottom of the zigzag by a separate downcomer from the drum. The tubes comprising each element are "in series," so that the water has a long course through which to run, in its complete circuit from the drum and back again. The water, after its transition into steam during its passage through the tubes, is delivered into the drum as foam—hence the name "foaming" type of water tube boiler.

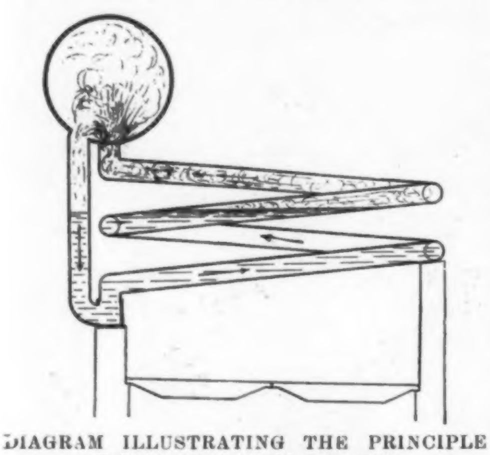


DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE BELLEVILLE BOILER.

The rough sketch, which we present herewith, illustrates the principle of the Belleville in a simple manner. The water is shown in the bottom tubes, and the passage the steam makes into the steam space of the drum is clearly demonstrated.

Only in one vessel of the British navy has the Belleville boiler proved successful to any degree. This solitary exception is the first-class cruiser "Powerful." In every other warship the boiler has proved an ignominious failure. Therefore a description of the boiler installation on this vessel—it is typical of the Belleville on all the English warships—is of interest.

The boiler equipment of the "Powerful" consists of a battery of 48 boilers, working at a maximum pressure of 260 pounds per square inch. The boilers occupy a total length of 186 feet, a great economy of space, as compared with what a similar battery of cylindrical boilers would occupy. The total power generated is 25,000 horse power; the total fire grate area is 2,192 square feet, and the total heating surface is 69,543 square feet.

Twenty-four of the boilers—one-half of the battery—have eight elements, and the remainder seven elements each containing 10 pairs of tubes.

The tubes are each about 6 feet 6 inches in length by 4½ inches in diameter. They are, however, of three thicknesses, this feature depending upon the close proximity of the tube to the fire. Those nearest to the fire are the thickest, being manufactured of ⅜-inch steel; those a little farther away are 5-16 inch thick; and the tubes placed the greatest distance from the fire are only 3-16 inch in thickness.

One of the greatest drawbacks of the Belleville boiler in the first warships of the British navy in which it was installed, was the leaky condition of the tubes. This was attributed to imperfect manufacture, as the boilers were made out of the country, and the material and standard of manufacture did not rise to the British Admiralty's requirements. To remedy this defect, the Naval Department decided to manufacture the tubes at home, and those utilized in the "Powerful" were the first so made. The tubes are manufactured from the best lap-welded mild steel, treated by the basic open-hearth process. The steel is subjected to severe tests, the tensile strain being from 21 to 24 tons, and an elongation strain of 25 per cent in the length of 8 inches. The other tests, equally severe, were heating a strip of the steel cut from the tube to blood heat, plunging it into cold water of 82 deg. Fahr., and then doubling it over a radius of ½ inch without fracture. Pieces of the 3 16-inch tubes 2 inches in length were heated and immersed in cold water, after which they were hammered down until the length was only 1 inch, and until the sides were close together, without showing a fracture.

These are severe tests, and typical of the examination the tubes for the boilers in the latest British vessels must undergo. Furthermore, the ends of the 3-16-inch tubes are expanded until the diameter is increased 12½ per cent in the case of a cold, and 20 per cent in the case of a hot tube. The tubes are also submitted to a water pressure of 1,000 pounds, and if solid-drawn tubes are employed, this pressure is increased 50 per cent to 1,500 pounds. These tests are carried out by the Admiralty inspector, so that only the best made tubes are employed.

By this rigorous method of manufacture, the danger of leakage has been overcome to a great extent. Yet even now there is an abnormal escape of water. The chief source of weakness is in the welds, and there appears, so far, no possible means of remedying it. As a matter of fact, this leakage is one of the inherent defects of the Belleville boiler.

The "Powerful," however, has achieved some very commendable cruising performances, and in no single case has the ship been laid up through failure of her boilers. This signal success has been attributed to the skillful stoking of the furnaces, which, it is stated, is not adopted in the other vessels equipped with this boiler. One of the peculiarities of the Belleville boiler is that the greatest care has to be observed in this direction, and if the furnaces be not skillfully stoked, the rate of both the coal and the water consumption will be somewhat high. This contention, however, has been dispelled as a fallacy, in the recent trials conducted for the investigations of the Boiler Committee organized by the Admiralty.

The most salient defects of the Belleville are generally conceded to be: leakage of water through the welds of the tubes; high water and coal consumption; liability to derangement; and difficulty of removing any defective tubes. The curved tubes have not, in the light of experience with the straight tubes characteristic of the Yarrow, Niclausse, Babcock & Wilcox, and other boilers, proved the best. At first it was considered that curved tubes were imperative to allow for contraction and expansion. If portions of the boiler are secured rigid by means of stays, and are not subjected to the same temperature as the tubes, it was averred that severe strains would be set up. Therefore, the tubes were bent in order to compensate the continued fluctuations of the temperature. But the bends in the tubes must be somewhat considerable, so that they can easily, and without excessive strain, suit the variations of the temperature. This principle involves other great drawbacks. Great trouble is experienced in cleaning the interior of a curved tube; a large variety of forms of spare tubes with curves of various shapes has to be kept in stock, to reinstate any that may be dam[illegible]ed, and the working is rendered far more difficult.

The Belleville is very susceptible to derangement, both the boiler itself and its numerous accessories, such as the feed and steam pipe systems. The enormous mass of mechanical detail of the Belleville greatly militates against its easy working. There are thousands of joints, all dependent upon extreme accuracy of workmanship. The feeding is also extremely delicate, owing to the small quantity of water contained, and also the variable weight of this water at different rates of evaporation. This latter condition necessitates the introduction of the hotwell pumps and large feed tanks. The feed regulator, although it works admirably, is a delicate mechanism, and has to be kept in a high state of efficiency. The number of boilers is also great for the power developed. This large subdivision has the advantage of involving only a small reduction of power, should one boiler become inoperative for any reason; but it also causes an enormous addition of important detail, such as feed pipe and steam pipe arrangements, all requiring care and attention. The furnace air-pumping engines are also an additional complication, involving many extra fittings.

The results of the investigations of the special committee of the English Admiralty with two vessels, one fitted with cylindrical and the other with Belleville boilers, and identical in every respect regarding dimensions, weight, etc., conclusively proved that the Belleville is an expensive boiler to maintain, especially when the vessel is running at low speed. But one of the most important characteristics of a warship is that it should be capable of running at a low speed, with a steam consumption proportionate to what it would be at full power. In other words, it should be quite as economical when running slow as when working at full speed. The Belleville is decidedly an expensive boiler for low speeds. For maintaining high speeds for long periods, however, it is well adapted, and under such conditions is very economical.

Under these circumstances, and taking all in all, the British Naval Department has decided to abandon the Belleville. Ten years ago, when the Belleville was invented, the Admiralty, under the peculiar exigencies of maintaining the war-vessels in an up-to-date, modern

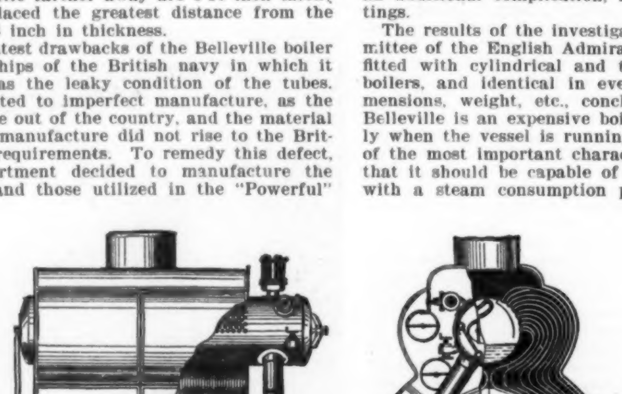


FIG. 1.—THORNYCROFT BOILER, "SPEEDY" TYPE, FOR GUNBOATS. TWO WATER-BARRELS AT EACH OF THE LOWER CORNERS; STEAM DRUM ABOVE.

state of efficiency, were justified in introducing it into the navy; but during the past ten years so many progressive developments of the water tube boiler have been made, that all marine engineers agree it is by no means the best water tube boiler on the market to-day.

THE THORNYCROFT WATER TUBE BOILER.

The Thornycroft water tube, which belongs to the "foaming" class, has achieved conspicuous success upon the smaller type of warships such as the torpedo boat, where high speed is imperative to attain efficiency. It was one of the first water tube boilers ever installed upon this type of vessel. During later years, however, it has proved so satisfactory in its working, that larger battleships are being fitted with it, notably the "Missouri" and "Ohio" of our own navy, while in the German navy the Schulz-Thornycroft water tube, an improvement upon the original conception, has become practically the standard steam generator.

The first Thornycroft water tube boiler applied to naval purposes was in 1885, when the gunboat "Speedy," of the British navy, was equipped with it. In this boiler, which is called the "Speedy" type, as may be seen from the accompanying diagram, the principle of construction consists of three horizontal drums, arranged in the form of a triangle. The two lower ones are the water barrels, and are connected by two large pipes, and a number of small curved generating tubes varying from 1 inch to 1¼ inches diameter, to one large upper chest, which is a steam and water drum. The two large pipes, which are placed outside the casing, carry the unevaporated water, conveyed to the upper drum with the steam and the feed water, to the lower barrels. By this arrangement a definite circulation and a constant flow of water over the heating surfaces are assured.

Water tube walls, built so as to follow the curves of the tubes in transverse section, inclose the tubes on either side, and at the lower and upper ends they are splayed so as to enter the drums. A space approximating the double diameter of a tube separates a tube from its neighbor, so that the hot gases from the fires are able to travel well round the tubes before they escape through the chimney. The gases enter the heating area from the firebox near the lower water drums, and emerge through two external rows on either side of the upper or steam drum.

The rows of tubes forming the walls over the firebox are bent so as to arch over the grate, and after meeting in the middle are bent back so as to enter the steam drum at the correct position. The reason for this arrangement is obvious—the gases are prevented from playing upon the lower surface of the steam drum. If the tubes are not so bent, the water in the steam drum would be set in ebullition; and if there were only a small amount of water therein, overheating of the drum would ensue. Another advantage of this principle of design is that ample play is given for the expansion of the tubes without throwing any strain upon the rigid parts of the boiler, or incurring the risk of starting the tubes at the points where they are expanded into the barrels.

The boiler is incased with asbestos and steel, and the ends are formed of firebrick attached to a vertical or sloping plate by means of dowels or bolts. Between this vertical plate and the asbestos and steel casing, a space is left in which the air doors, opening inward, are placed to permit the air current passing over the brick plate and down into the ashpit. The latter is also provided with air doors to offer a protection to the stokers from any rush of steam that may issue from a bad leak.

The "Speedy" type of boiler was found very efficient for gunboats, but when the British Naval Department introduced the torpedo-boat destroyer, which had to fulfill a special class of work, and for which high speeds were essential, an improvement was made. Such a light craft as a torpedo-boat destroyer would not allow any increase being made in the size and weight of the boiler, so in order to economize space and weight, at the same time obtaining a larger grate area, the boiler was designed upon the principle shown in Fig. 2, and is known as the "Daring" type. Instead of two small barrels at the bottom extreme ends of the triangle, one barrel is placed directly beneath the steam drum. The two barrels are connected by a number of downtake tubes, each about 4 inches in diameter, bent for purposes of construction, and also by series of curved generating tubes bounded by the water tube walls. The firegrate is arranged on either side of the lower water barrel. Thus two fireboxes are provided and are bounded on the outside by the water tube wall, as in the "Speedy" type, and on the inside by one of the two groups of tubes. The wall tubes are supplied with water by a pipe connected with the lower barrel, and are bent round on the outer sides of the grates.

In this arrangement, the gases pass through the firebox walls into space among the tubes by apertures near the lower barrel, and travel upward in a diagonal direction, finally escaping through the central walls into the heart-shaped central space beneath the upper barrel, thence along to the back of the boiler into the chimney.

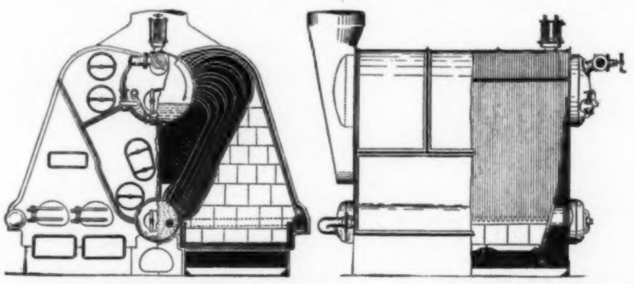


FIG. 2.—THORNYCROFT "DARING" WATER-TUBE BOILER FOR TORPEDO-BOAT DESTROYERS. ONE WATER BARREL BELOW THE STEAM DRUM.

Owing, however, to the demand for larger boilers of this type, the number of tubes has necessarily been increased in the wing barrels, and in several boilers that are now in use there are as many generating tubes in the wing barrel as in the central groups. The former, however, constitute flues with water tube walls in precisely the same manner as those in the center.

A further improvement was carried out in this type of boiler by the arrangement with Messrs. Krupp, the famous armament constructors of Essen, whereby a combination of the Schulz and Thornycroft boilers was effected. The Thornycroft-Schulz boiler is essentially a development of the "Daring" type. At the bottom there are three water drums, one placed in the center between the fireboxes, and one at each outside corner. In this type, however, the steam is delivered into the steam drum both below and above the water in the drum, so that it is in reality a combination of the "foaming" and "drowned" classes. The Thornycroft-Schulz boiler, however, is well adapted for large vessels, and is the type of boiler introduced in the German navy with such conspicuous success.

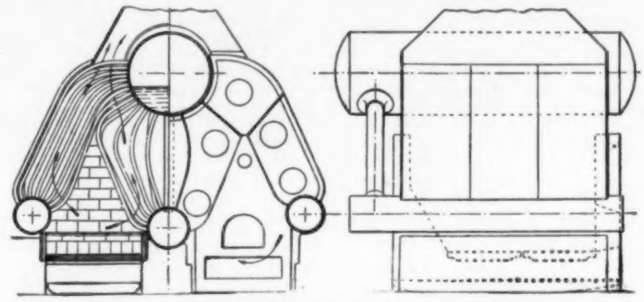


FIG. 3.—THE THORNYCROFT-SCHULZ BOILER. THREE WATER-BARRELS AND GENERATING-TUBES DELIVERING STEAM INTO THE STEAM DRUM ABOVE AND BELOW THE WATER LEVEL.

One of the most difficult problems in connection with all water tube boilers, is the regulation of the water feed. It is imperative that the supply should be uniform. The Thornycroft regulator is now largely employed upon water tube boilers, not only of the Thornycroft but of other types, owing to its simplicity and efficiency.

Broadly speaking, it is an adaptation of the ordinary cistern valve, the lever actuating the valve, and carrying the float and balance weight, being supported on a bell crank. The latter is also actuated by a connecting rod and a spindle passing through a stuffing box for purposes of adjustment. By this arrangement the height of the fulcrum of the lever can be altered, and the level of the water at which the valve shuts can be varied accordingly. One important advantage of this gear is that it is very useful for distributing the water in a uniform flow, when two or more boilers are fed from the same pump. The gear is placed in the upper barrel, and a perforated pipe distributing the water along the interior is connected to the outlet. When once placed in position, the valve gear requires no attention, notwithstanding the extreme fluctuations of the power. The pressure, which should be kept steady, need not exceed 50 pounds per square inch in the feed pipe, above the steam pressure to insure efficient working.

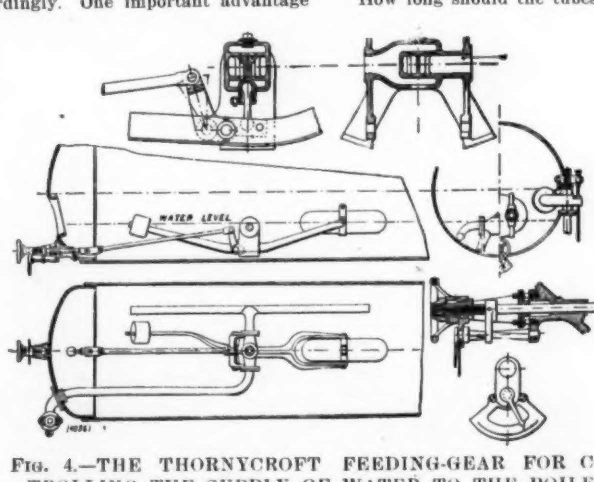


FIG. 4.—THE THORNYCROFT FEEDING-GEAR FOR CONTROLLING THE SUPPLY OF WATER TO THE BOILER.

One of the most distinctive features of the Thornycroft boiler is the easy accessibility to the component parts, since the boilers are so arranged that the flues and outside of the tubes can be easily seen and cleaned. Although the tubes are bent, the curves are so easy that a wire brush passed through them will remove any deposit adhering to the inner surfaces. In the case of a tube breaking down it can be quickly removed, and a new tube substituted.

Economy in coal consumption is also assured, since the fireboxes are capacious, and the arrangement of the air doors renders combustion very complete, so that the maximum of heat is derived from the minimum of coal, while there is a conspicuous absence of black smoke from, or flaming at, the funnels, a very vital consideration so far as naval purposes are concerned.

Another important factor is the provision of good circulation by return tubes, through which a constant uniform flow of water is obtained. A large percentage of the breakdowns with water tube boilers is due to the defective circulation in the return tubes. In England, engineers favor a small number of tubes of larger diameter; in Germany, the provision of several small tubes is advocated, but there does not appear to be any greater advantage accruing from one system of return tube more than from the other.

It is often averred that forced draught militates against the satisfactory manipulation and efficiency of a water tube boiler, the contention among certain engineers being that low air pressure is much more advantageous, because forcing means a higher fuel consumption. *En passant*, it must be explained that the extent to which a boiler is forced depends upon the number of pounds of coal per square foot of grate burnt in a specified time, and in the same boiler a larger quantity of coal will be consumed with a high than with a low air pressure. But the air pressure is far more a measure of the resistance of the boiler to the passage of the gases, than of the rate of combustion; and this point is generally overlooked by the advocates of low air pressure, who do not recognize the all-important fact that one boiler is not necessarily burning more coal per square foot of grate than another of different type, because it is working with higher air pressure. As a matter of fact, some types of multi-tubular boilers will not permit, from their principle of construction, of forcing.

In some instances, however, high air pressure is a distinct advantage, since the augmented air pressure can be utilized to make the gases from the furnace traverse a more circuitous route among the tubes, so as to pass over a large area of heating surface, whereas with the low air pressure the gases are often blown straight from the firebox into the funnel.

The Thornycroft boiler is essentially a high air pressure boiler, though by means of slight constructional alterations it can be made a low air pressure boiler if desirable. But it is under the first named conditions that it yields the greatest satisfaction.

How long should the tubes last? is another point of vital importance concerning a water tube boiler. Obviously, if the tubes have to be constantly overhauled, and renovated, a multitubular boiler is not going to prove economical or trustworthy. With the Thornycroft boiler a life of about eight years is regarded as normal, so that it can be considered a highly durable boiler. But the life of a tube naturally depends to a great extent upon the treatment it receives, though the material of which it is constructed exercises a far-reaching influence upon its durability. So far as the latter question is concerned, it is imperative that the

steel should be homogeneous and of regular structure, and that the chemical composition should be suitable. As previously explained in connection with the Belleville boiler for the English naval vessels, the Admiralty submit the tubes to very stringent tests.

One of the most general reasons for deterioration of the tubes is permitting the boilers to stand partly filled with water and the rest of the space occupied with damp air. Consequently corrosion sets in. Attempts have been made to prolong the life of a generating tube by galvanizing the internal surface, but investigations have proved that such a coating of zinc in reality forms a starting point for corrosion.

Mr. Thornycroft, F. R. S., the inventor of the multitubular boiler of the same name, carried out some interesting experiments in this connection to ascertain whether galvanizing afforded any real protection. The tubes for the purposes of the experiments were galvanized both inside and out. The zinc on the outside proved more useful than the inner coating, as the latter, being exposed to impure water at a high temperature, soon disappeared, and was, therefore, only a temporary protection. In connection with the galvanized tubes a curious phenomenon was often experienced. In opening up boilers and steam pipes treated in this manner, explosive gases were encountered in the tubes and pipes in unpleasant quantities. Researches showed that the zinc must have been the cause of the generation of these gases.

In one case a torpedo boat had been lying with banked fires for five days. A leak was discovered in the exhaust pipe of the steering engine, and the presence of a combustible gas was accidentally made evident by its ignition, when it burned for three or four minutes, the flame being about three feet long, burning at first with a blue flame, and later with a luminous flame like coal gas.

Sea water is often opined to be a dangerous enemy to the durability of the tubes, but this contention has been proved fallacious by actual experience, though if a boiler is laid up for a long period, half full of damp air, corrosion will inevitably ensue. A comprehensive illustration of the erroneous idea of sea water affecting a multitubular boiler was afforded by the torpedo boat "Ericsson" of the United States navy, equipped with the Thornycroft boilers, which went right through the siege of Santiago and used salt water the whole time.

One of the greatest difficulties against which the water tube boiler engineer has to contend is "priming." Some types of multitubular boilers are more susceptible to this complaint than others. In many instances, priming is caused entirely by the use of bad water. In this direction Mr. John Thornycroft, F. R. S., has also made some interesting researches. By means of an experimental boiler with the generating tubes fitted with glass ends, to enable him to follow the internal working of the boiler, he obtained some valuable information regarding priming. Waters which cause priming on boiling produce foam, consisting of a mass of bubbles of various sizes. Water which is very bad produces bubbles so durable that it is some time before they break, and the steam space of the drum becomes entirely filled with them. When this takes place, instead of steam leaving the boiler, the discharge consists of foam, which is broken up in its rapid motion along the steam pipes. This is a great contrast to what was observed when pure water was being evaporated. In this case the steam as it left the surface of the water showed no trace of a film of liquid. Steam from pure water is incapable of forming bubbles. The effect of this was emphasized in the discharge from the tubes delivering into the steam drum above and below the water line respectively. In the former case, with pure water, the discharge of steam and water was periodic. The water and steam were discharged quite separately, but with a priming water the discharge was a steady one, consisting of a mixture of steam and water in the form of very wet foam.

In the case where the tubes discharged below the water line, the flow appeared to be unsteady in both cases; when the water was pure, the water and steam were discharged together, as in the above-water delivery; then at the pause in the flow the water ran back into the tube onto the ascending column, so that there was to some extent an alternating flow in the upper ends of the tubes. This occurred in the same way with a priming water, only to a more marked extent, columns of foam being thrown the full height of the separator. From the investigations it will be seen that tubes delivering below the water line are capable of causing a priming effect, when tubes delivering above the water line will not do so.

The impurities in water which may cause priming are not easy to determine. It is well known that waters which do not prime by themselves will do so to a most astonishing degree when mixed. Thus either salt or pure water may work in a boiler without priming, but if they are mixed, violent foaming results.

SNOW MUSHROOMS.

By ENGLISH CORRESPONDENT OF SCIENTIFIC AMERICAN.

DR. VAUGHAN CORNISH, F. R. G. S., has been describing the result of his investigations into the curious phenomena concerning the snow formations to be found in the Canadian Selkirks, before the Royal Geographical Society of England. This is the first elaborate survey that has been made of these "snow mushrooms" as they are popularly called, owing to the remarkable *vraisemblance* they bear to this fungus, and the result of his investigations has proved of great value in connection with the adhesive and other peculiar qualities of snow. The explanation of the cause of these formations has long been a point of controversy among scientists, but hitherto the explanations as to their origin have not been very convincing. Dr. Cornish, however, spent several weeks during the winter of 1900-1 among the Selkirk mountains studying the phenomena, and his observations have supplied much conclusive information upon the subject.

Dr. Cornish divides snow into two principal classes—wet and sticky snow, which falls about 32 deg. Fahr.; and dry, slippery snow, which falls at about 0 deg. Fahr. or at any lower temperature. The subsequent modifications of the snow appear to depend upon pressure, temperature, radiation, and wind. The snow mushrooms are formed in moist snow, and were studied by Dr. Cornish in the neighborhood of Glacier House, B. C., from February 4 to 12, 1901. Regular observations of temperature and snowfall were taken by the local superintendent of the railroad; at the date of Dr. Cornish's visit the registered snowfall was 25 feet, and the depth of snow upon the ground was 5 feet. There was no sign of drift in the valley. Most of the snow here falls at or about 32 deg. Fahr., so that although zero weather is often experienced, the snow as it falls is adhesive. The air is also usually calm during the snowfalls.

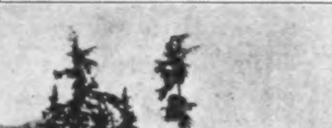
A snowfall of 12 inches in an hour is by no means uncommon here. The rate of subsidence of the flakes, Mr. Vaughan Cornish found to be 2 miles per hour; the column of air of 1 square foot section, which contains 1 cubic foot of snow, is 2 miles, i. e., 10,560 feet high. It appears to be generally the case that the eye conveys an utterly misleading idea of the relative contents of a number of small particles and of the space in which they are distributed.

In the prairies prominences stand out free from snow, at least on their upper windward faces, but cause large detached drifts to accumulate in their neighborhood, a small drift being also usually attached to the leeside of the obstruction. At Glacier House, on the contrary, the chief feature produced by the prominence is a concretionary growth based upon its upper surface, beyond which it ultimately extends with overhanging eaves. There is also sometimes a mass of snow attracted to the windward side of the obstruction.

In the case of the drifts of the prairie snow, the prominence of the snow banks is increased by the deficiency of snow to leeward of and between the inclosing arms of the snowbank. In the case of the mushroom-like caps upon the tree-stumps at Glacier House, the associated depression is beneath, where the ground is sheltered as by an umbrella.

In felling trees, a stump of several feet in height is always left, and this forms the stalk of the "mushroom." When the stumps are short, the rim of the snowcap touches the surrounding snow surface, and the appearance presented is then similar to an ordinary boss instead of a "mushroom."

One authority, Heim, describes the formation of overhanging cornices of snow by the adhesion of the flakes



SNOW MUSHROOM 9 FEET IN DIAMETER.

of moist snow (at about 32 deg. Fahr.) when eddying round in a wind on the leeside of an Alpine ridge. The bosses and caps on the tree stumps at Glacier House are so far similar to these snow cornices that their projecting eave is due to such adhesion. Their spheroidal shape, however, does not conform to active modeling by eddies. In one spot where the "mushrooms" were exposed to gusts of wind coming down a glacier valley, this fact was well illustrated by the remodeling of the spheroidal cap to a shape resembling that of a peg top, but with edges meeting at the point.

The snow mushrooms appeared to have attained to perfect spheroidal symmetry as the result of a completed growth upon the circular platform of a cylindrical pedestal.

The process of growth of the snow mushroom is inferred (a) from observation of the completed structure; (b) from observations at various times of the occurrences during the fall of moist snow in Canada, Britain, Switzerland, and the Tyrol; and (c) from the probable operation of regelation.

Moist snowflakes adhere far better to a snow surface than to any other. When the wind is light, which is the case here, the snow surface remains rough, presenting many points for attachment, and perhaps diminishing the already small velocity of the air near the surface. Also there is no melting, such as sometimes hinders accumulation of snow upon foreign surfaces. But Dr. Cornish is of opinion from the result of his investigations that the most important factor in such concretionary growth is union by solidification of the films of moisture where the snowflake touches the snow surface.

The upper surface of this snowflake, which is exposed to the air, remains moist until another flake falls upon it, when it is supposed the surfaces in contact are united, as above, by a thin layer of ice, which is then a part of the structure of each snowflake.

The touching surfaces must be, in the first case, a very small fraction of the total area of surface of the snowflake. As the depth of the deposit increases, the pressure of the superincumbent layers slowly squeezes air out of the lower layers. These become more compact and more tenacious, both by the filling up of interstices by repacking of material, and also by regelation.

When Dr. Cornish attempted to detach a small snow mushroom from its pedestal, he found it was very firmly fixed. This was proved to him by his driving a long pole into the mass of snow, which was about 4 feet across, when it was found to be rough and tenacious, and attempts to dislodge it proved futile. The pedestal was a broken, rotten tree, about 1 foot in diameter and 12 feet high. Dr. Cornish placed two poles against the tree, and gave successive pushes until the tree rocked violently, when at last the snowcap fell, but intact, and it was not broken by its impact with the snow beneath.

At Glacier House the mushrooms on all but the largest tree stumps were considered to be as large as the pedestal was capable of supporting, i. e., the eaves of snow overhung the support as far as possible consistently with the limit of cohesion of the material and the size of the base. A stump 2 feet in diameter had a cap of snow 9 feet across, the eaves projecting 3 feet 6 inches all round the pedestal. The largest tree stumps would probably have supported somewhat larger snow caps had the depth of snow been greater; but, as well as could be judged, the projection of the eaves was as great as was consistent with the amount of snow which had fallen, and with the cohesion of the material. A broken tree with a diameter of 4 feet had a snowcap 12 feet across, the eaves projecting 4 feet beyond the pedestal. Some of these snow mushrooms the scientist computes to have weighed a ton.

What happens when more snow falls upon a fully grown mushroom? If the strata of successive snowfalls remained horizontal in the eave of a snowcap, then, as the strain would be greatest at or near where the leverage is greatest, the eave would break off close to the pedestal. Thus, where there are many fully grown mushrooms, one would expect if their structure were of this kind to find in their company the ruins of a considerable number which had received rather more snow than they could support. In point of fact, however, Dr. Cornish saw scarcely a tree stump of 2 feet or more diameter near Glacier House of which the snowcap was in ruin. The absence of ruins, of considerable breakage, and even of untidy fragments, contributed greatly to the beautiful and singular appearance of the mushroom tract.

That the snow mushroom is, on the whole, so remarkably preserved from sudden ruin by overloading it attributed to bending of the strata under the action of gravity, the inclination to the horizon increasing with the distance from the pedestal. The rough edge of the rim Dr. Cornish saw is strikingly contrasted with the smooth dome of the structure. The rough edges shown were the pendent strata broken off by their own weight ruining the whole structure.

There is also another means by which this structure can get rid of additional snow deposited upon it, viz., by the slipping of the loose surface layer from the highly inclined lower strata near the rim of the mushroom. This slipping may be assisted by lubrication of the harder subjacent stratum when surface snow is melted by the sun, since snow has been observed to melt in the sun during hard frost in February at Glacier House.

The perfect representation of a mushroom by the snowcaps on the tree stumps at Glacier House is largely an accident of proportion between the amount of the snowfall, the diameter of the forest trees and the height of stump usually left in felling. Where the trees are small the base cannot support a sufficient quantity of snow, and, on the other hand, nearer the Pacific coast, where the trees are of giant growth (with a diameter often of 14 feet) the snowcap appears more as a thatch with overhanging eaves.

A well-developed specimen has a profile similar to that acquired by the "spreading chestnut tree" and other trees of similar habit, such as oak and beech. The complete form is best seen where, cattle being excluded, the lower branches sweep the ground. As in the case of a snow mushroom, the form is due to bending under the action of gravity.

UNSEASONABLE WEATHER IN THE UNITED STATES.

THE cause of unseasonable weather is not demonstrable. Neither is it possible in all cases to determine which of the general atmospheric conditions that are associated with unseasonable weather partake of the nature of cause and which of effect.

It has been observed that summer periods of low temperature are associated with barometric pressure below the normal and abundant rainfall, and that summer periods of excessive heat are associated with barometric pressure about or above the normal and a marked deficiency in rainfall. It has also been observed that winter periods of excessive cold are associated with barometric pressure above the normal and little or no precipitation, and that periods of high temperature in winter are associated with barometric pressure below the normal and rain or snow. It has been observed further that the general atmospheric conditions referred to are associated with areas of high and low barometric pressure that traverse the United States. In summer the atmosphere over regions subjected to unusual cold and abnormally heavy rainfall is dominated by areas of low barometric pressure, or general storms, that follow unusual tracks for the season, and the atmosphere over regions subjected to unusual heat is undisturbed by the passage of general storms, and is dominated by an extensive and almost stationary area of high barometric pressure. In winter periods of excessive cold are experienced in connection with areas of high barometric pressure of great magnitude that advance from the British Northwest Territory, and also in connection with general storms that follow abnormal southerly paths, and periods of unusually warm weather occur in connection with a succession of general storms that pursue abnormal northerly paths.

A study of the daily meteorological charts of the Northern Hemisphere shows that the general atmospheric conditions over the United States that are associated with unseasonable weather in any part of the country are, in turn, associated with atmospheric conditions that obtain over at least a great part of the

Northern Hemisphere. The international charts show that when a period of abnormal weather prevails over a considerable area of the United States, there is a disarrangement of the normal distribution of atmospheric pressure over a great part of the Northern Hemisphere. They show that in the presence of unseasonable weather in any part of the Northern Hemisphere the so-called permanent continental and oceanic areas of high and low barometric pressure present abnormal aspects, and there is an interruption in the normal succession and progression of the areas of high and low barometric pressure of the middle latitudes.—Prof. E. B. Garriott, in the Monthly Weather Review.

THE NAVAL WAR GAME—II.*

THE WAR—VARIOUS MOVEMENTS.

By FRED T. JANE.

DIRECTLY war broke out, both sides put all available ships in commission. Mostly this affected the coast defense squadrons, both far removed from the scene of war, and commerce-attack cruisers, which were destined to have an early meeting.

The United States Mediterranean squadron, which was assumed lying at the Piræus, was cabled to proceed to the Far East, and sailed for Suez the next day.

The South Atlantic squadron proceeded to sea, with a view to trying to entice to action the Germans in those waters. The Home fleet cruised up and down the coast, awaiting developments and practising battle evolutions, etc. Its cruisers, together with others newly commissioned, went out along the trade route.

On the German side the first Home squadron went to Gibraltar at full speed, accompanied by colliers and its destroyers. It reached Gibraltar on the 7th of August, 1903—seven days after the breaking out of the war. By this time the United States Mediterranean fleet was well down the Red Sea. This German squadron, short of several cruisers, coaled at Ceuta from its own colliers.

Both sides adopted somewhat similar dispositions for their cruisers, that is to say, there was little spreading with them. All ships maintained close touch with consorts, hunting rather for hostile cruisers than attempting action against commerce. A few liners were chased, but the speed of these saved them, nor were the attempts to follow serious. In this way the rival squadrons had fairly clear ideas of each other's whereabouts, and a meeting was not therefore long delayed.

CRUISER ACTION IN MID-ATLANTIC—GERMAN VICTORY—CAPTURE OF THE FLAGSHIP "OLYMPIA" AND THE "DETROIT"—FOUR AMERICAN CRUISERS SUNK.

Informed by wireless telegraphy from the "Columbia" and the "Thetis," which were the first ships to establish touch, both sides concentrated in mid-Atlantic. Neither was in a hurry to open the battle, preferring to wait for fresh reinforcements; and so for a whole day nothing happened save attempts to secure the most advantageous position. Toward sunset, however, both squadrons edged in toward each other, and the Germans, though they had fewer ships, being the heavier, took advantage of this to open the battle.

They then lay to the north of the Americans, being in the following order, the flagship to the eastward: "Prinz Heinrich" (flag), "Victoria Luise," "Gefion," "Amazone," "Thetis," "Ariadne," all steaming due south at 18 knots in line abreast. The Americans at that moment were in two divisions some half a mile apart. The first, steering northeast, consisted of the "Olympia" (flag), "Columbia" and "Minneapolis;" the second of the "Raleigh" (senior ship), "Cincinnati," "Detroit," "Marblehead" and "Montgomery," steering northwest in line abreast, while the first division was in line ahead.

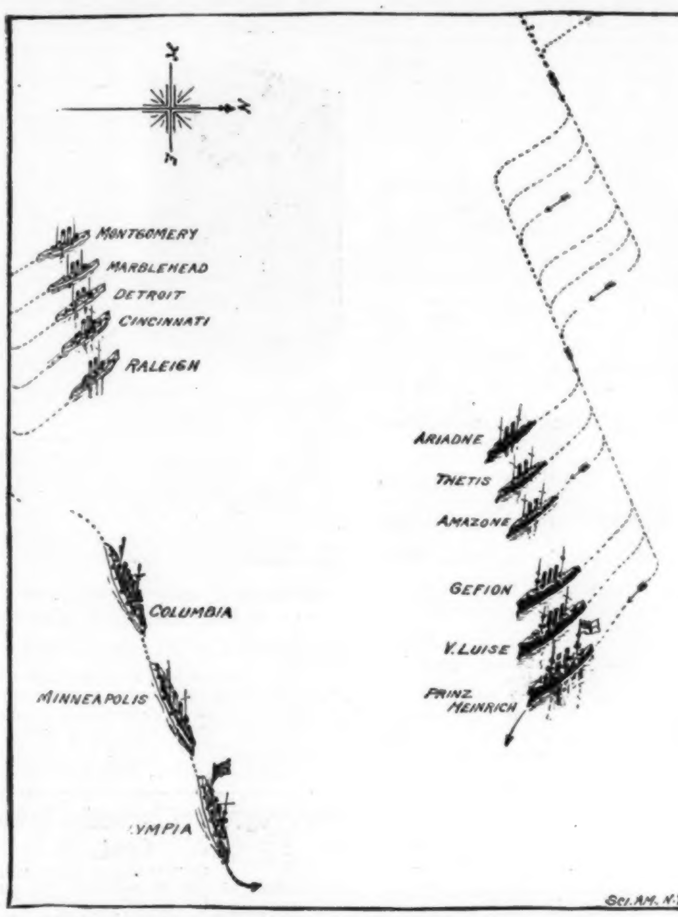
Fire was opened at 6,000 yards, but this range was speedily reduced to 3,000. All German guns were laid on the foremast of the flagship "Olympia," with the result that the incident of the battle of Cape Bojeador was repeated in so far as the American admiral was concerned. At an early stage he was umpired "killed," and command passed to the captain of the "Minneapolis," who was second in command. American guns were, however, directed with a similar objective and with a similar result.

To this, perhaps, rather than to any direct intent was due the fact that the first divisions became involved in a *melée* well inside torpedo range. As a result of this and short range gunfire the "Olympia" was soon reduced to a sinking condition, the "Prinz Heinrich" sunk (by torpedo), the "Columbia" and "Victoria Luise" rendered unmanageable. Only the "Minneapolis," rather mauled, and the "Gefion," which declined close action, were in any condition to do much further work in the two first divisions.

Meanwhile the second German division, headed by the "Gefion" from the first, passed up between the two American divisions, torpedoing the disabled "Columbia" to port and the "Marblehead" and "Montgomery" to starboard. The range was small, and many of the American ships being without torpedo tubes, and none having submerged ones, all the advantage of this stage lay with their German adversaries. Perhaps, indeed, it lost them the day. Possibly the Germans would never have attempted the maneuver had the torpedoes been more equally matched.

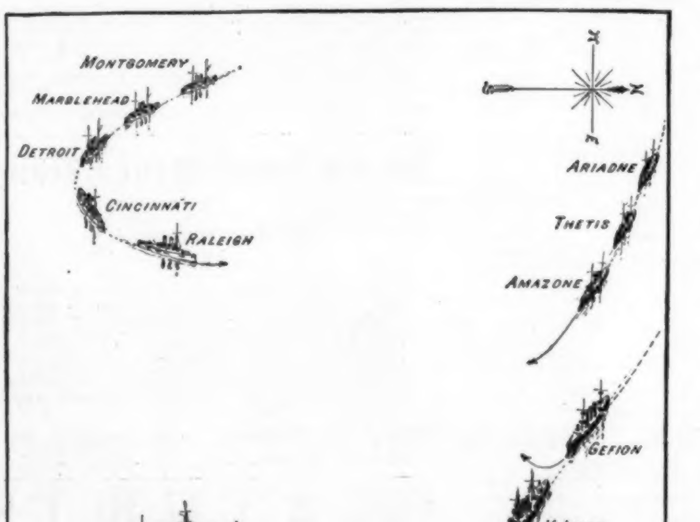
What was left of the two American divisions went on, seeking to join the "Minneapolis;" while the Germans, with one cruiser unmanageable, still bore northwest for a while. Here they reformed into line abreast, and returned to the fight.

Meanwhile the "Victoria Luise," torpedoed in the bow, made use of such headway as was left her to drift alongside the disabled American flagship

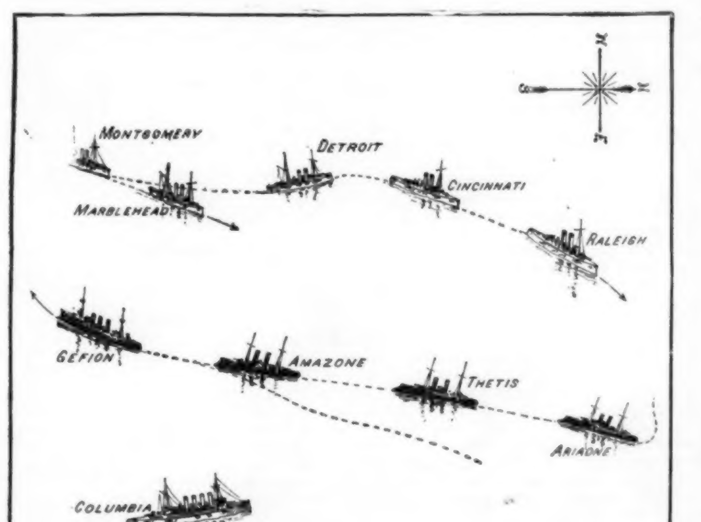


MID ATLANTIC CRUISER ACTION—POSITION AT OPEN FIRE.

* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.



MID-ATLANTIC CRUISER ACTION—SECOND STAGE.



MID-ATLANTIC CRUISER ACTION—THIRD STAGE.

"Olympia." After the desultory exchange of a few shots, the Germans made an attempt to board. This attempt was a failure; but as at this time the second German division was close by, threatening to torpedo, the "Olympia" was compelled to strike*—further fighting being massacre only.

The delay consequent on this incident, coupled with the previous delay due to the reforming of the second German division, enabled what was left of the Americans to get into line, and three ships, led by the "Raleigh," opposed the German advance, bearing off to the northeast. In the encounter that ensued the "Cincinnati" was sunk and the advancing Germans mauled enough to make them slow down, thus permitting the two remaining Americans to escape. Giving up the chase, they returned to the prizes, scuttling the "Olympia" and towing the "Detroit" back to Kiel.

DAMAGES SUSTAINED.

German Ships.

"Prinz Heinrich." (Two 9.4-inch, ten 6-inch, ten 3.4-inch.) Sunk by torpedoes.

"Victoria Luise." (Two 8-inch, eight 6-inch, ten 3.4-inch.) Torpedoed in extreme bow. One casemate out of action; little damaged otherwise.

"Gefion." (Ten 4-inch.) Two guns out of action. No other damage.

"Amazone." (Ten 4-inch.) One funnel gone and forward guns out of action.

"Thetis." (Ten 4-inch.) Badly raked on waterline. Boiler room penetrated. Scuttled by the Germans on account of the impossibility of getting her home.

"Ariadne." (Ten 4-inch.) Funnels damaged; otherwise unhurt.

American Ships.

"Olympia." (Four 8-inch, ten 5-inch.) Torpedoed in the extreme stern. Nearly all guns disabled. Compelled to strike. Subsequently scuttled by the Germans.

"Columbia." (One 8-inch, two 6-inch, eight 4-inch.) Sunk by torpedoes.

"Minneapolis." (One 8-inch, two 6-inch, eight 4-inch.) Waterline aft badly hit. Forward 6-inch out of action. Escaped.

"Cincinnati." (Eleven 5-inch.) Sunk by gunfire.

"Raleigh." (Eleven 5-inch.) Amidship guns all disabled. Escaped.

"Marblehead." (Nine 5-inch.) Sunk by torpedo.

"Montgomery." (Nine 5-inch.) Sunk by torpedo.

"Detroit." (Nine 5-inch.) Battery severely damaged by gunfire. Ship rendered unmanageable. Cut off and compelled to strike.

A summary of the guns in the opposing fleets is as follows:

Inches	9.4	8	6	5	4	3.4
German	2	2	18	—	40	20
U. S. A.......	—	6	4	59	16	—

Here, though a numerical equality is apparent, there is, when we remember that a single 6-inch is probably worth two 5-inch so far as shell effect is concerned, a great German superiority. The "Columbia" type in particular is very lightly gunned. The absence of submerged tubes was, however, the thing from which the Americans suffered most. The first division risked using their above-water ones, and, as luck would have it, were not hit in the torpedo rooms till the tubes had been emptied; but all these tubes were put out of action before the battle was half over.

(To be continued.)

* By direction of the umpire, whose decision alone governs such questions.

FIXATION OF NITROGEN BY ALGÆ.

When we expose pots of sand to which phosphates, potash and magnesium salts have been added, to the usual soil of a garden, we soon find that they get covered with various green algæ; and if we chemically analyze the surface of the sand, we often find a considerable amount of nitrogen, rising sometimes to as much as 0.08 per cent.

Messrs. Schloesing, Jr., and Laurent, observed the fixation of nitrogen by algæ in experiments, in which they noticed the diminution in volume of this element in a confined atmosphere, even in the presence of Leguminous plants, if the sand were covered with green algæ.

Later, M. Kossowitsch has reported that this fixation of nitrogen from the atmosphere by the algæ only took place when these were associated with bacteria. M. Bouilhac found by exact experiments that the algæ, Nostoc punctiforme, sown in a sterilized mineral solution without a supply of nitrogen, does not develop, but that it is otherwise when this algæ is associated with soil bacteria; this fact has been observed at Rothamsted.

M. Stoklasa often got vigorous blue Lupins growing in sand, and yet bearing no nodules on their roots. M. Denoussy also observed the same fact, but only when the pots of sand had been invaded by algæ, and especially by certain species, which avoid full daylight, by retiring below the surface of the sand. It must, however, be recognized that though it is easy to observe the various algæ which cover the sand, and to note that the sand has gained nitrogen, it is much more difficult to see the bacteria presumably associated with the algæ.

To sum up the subject, it is perfectly established that Leguminous plants bear bacterial nodules on their roots, and fix free and uncombined nitrogen from the atmosphere. This is a point gained, and it explains the name of ameliorant plants, by which they have long been designated.

The question must be asked: Are these the only plants which have this power? Do the Algæ equally possess it? Can the lower plants get possession of atmospheric nitrogen only as far as they are associated with bacteria organisms? These points further investigations have to prove.

The above facts have been summarized from Prof. Dehérain's second edition of his Traité de Chimie Agricole, 1902. J. J. Willis, Harpenden.

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